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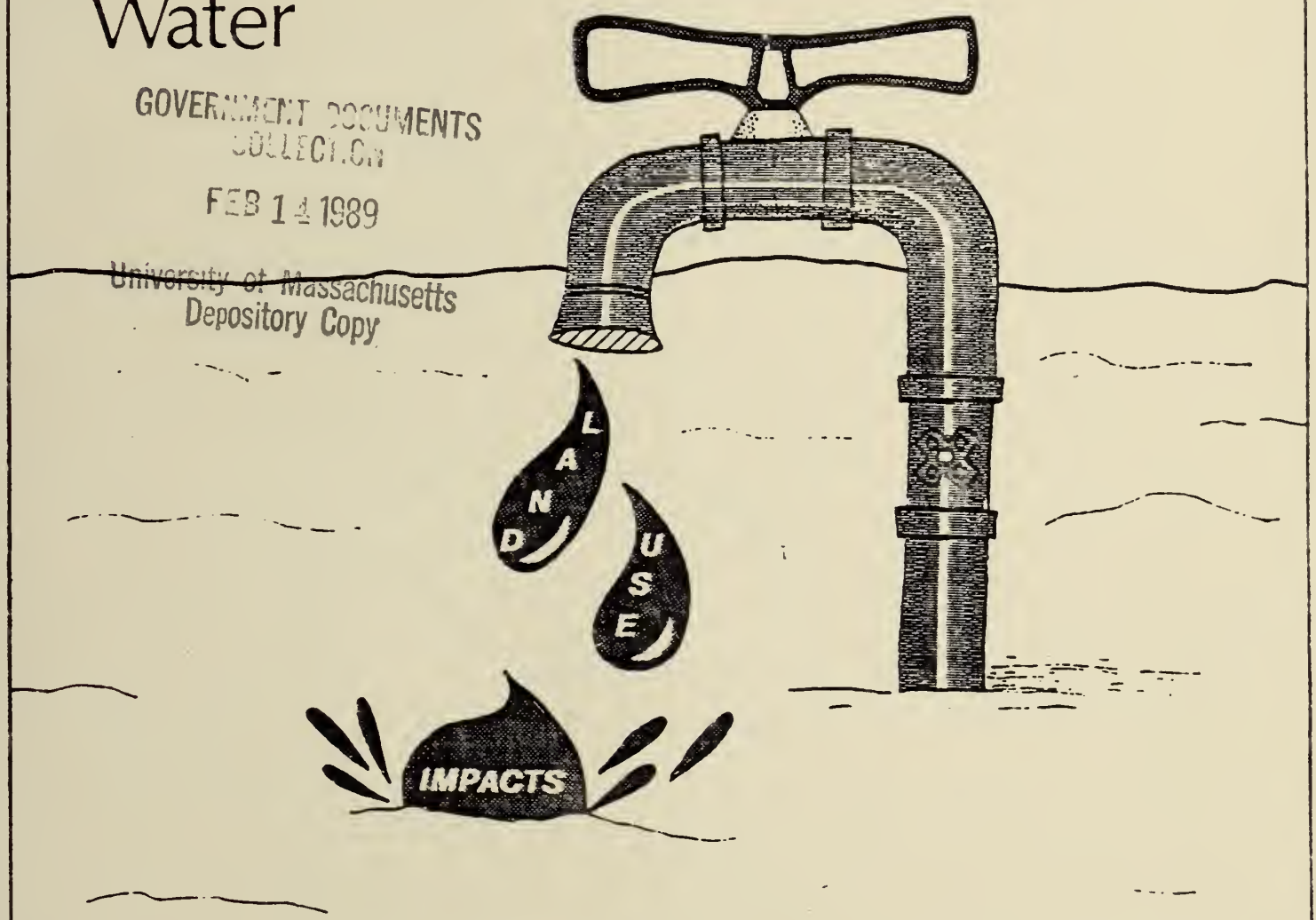

WEYMOUTH WATERSHED PROTECTION STUDY

Metropolitan Area Planning Council

JULY 1984

SBV/327

WEYMOUTH

WATERSHED PROTECTION

STUDY

JUNE 1984

METROPOLITAN AREA PLANNING COUNCIL

BOSTON, MASSACHUSETTS

ABOUT THIS REPORT

This report was prepared by the staff of the Metropolitan Area Planning Council under the supervision of its Executive Director. The Metropolitan Area Planning Council is the officially designated regional-planning agency for 101 cities and towns in the Boston metropolitan area. The Council offers technical assistance to its member communities in the areas of land use, housing, environmental quality, energy, transportation, and economic development.

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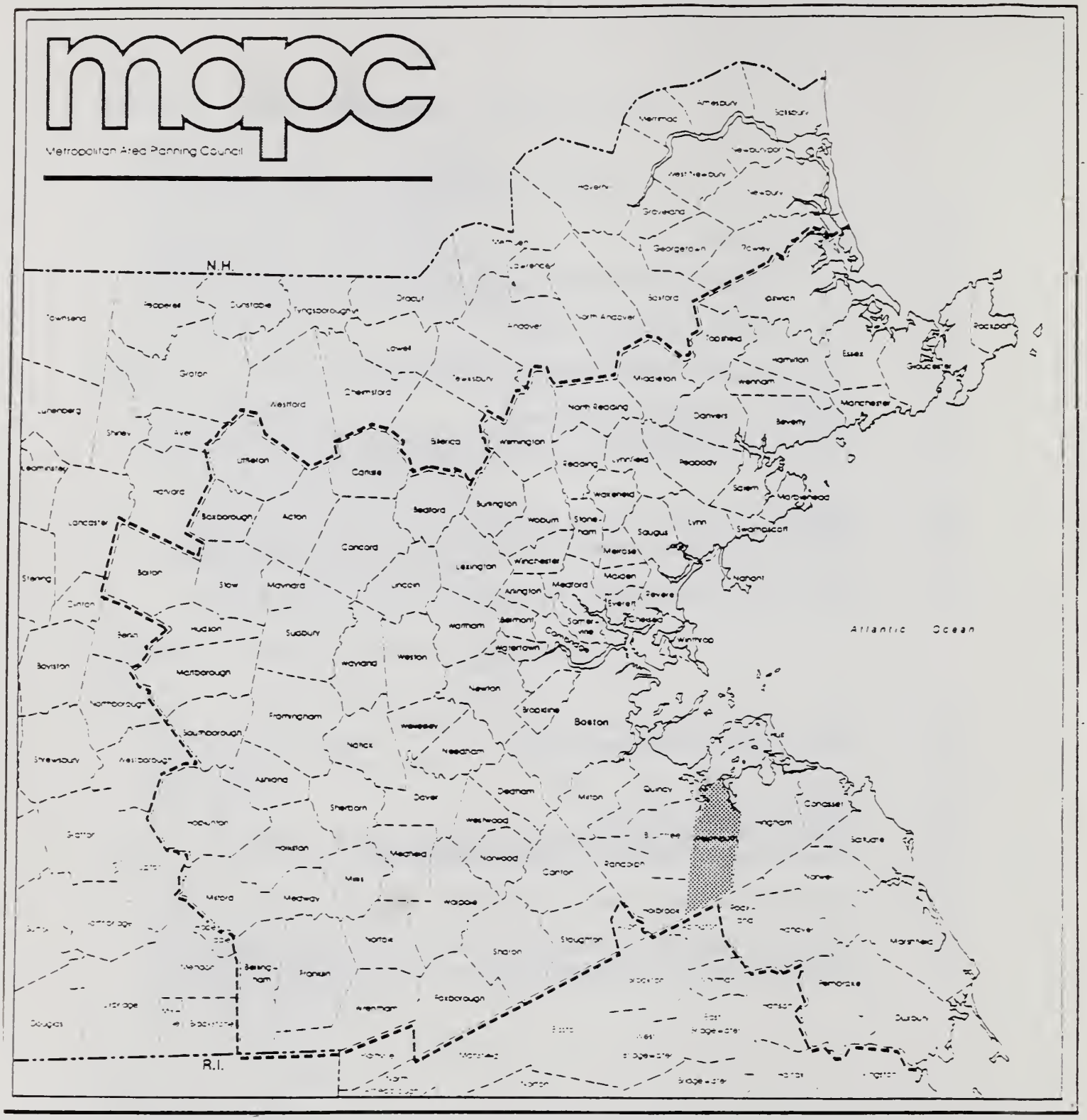
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CHAPTER 1

BACKGROUND AND NEED FOR THE STUDY

This technical assistance report was prepared at the request of the town of Weymouth, whose officials have expressed interest in protecting the town's water supply sources. Weymouth meets all of its water supply needs with local sources of surface and groundwater, which includes two reservoirs and five wells. Weymouth is a relatively urbanized community of 55,000; at present about 55 percent of the watershed which recharges the town's wells and reservoirs is developed. This study addresses the need for improved watershed protection to insure the quality and quantity of the town's water supply. It examines the adequacy of existing regulations to protect sources of water supply from existing and potential sources of contamination, and makes recommendations for improved water supply protection.

The study area for this project includes those portions of Weymouth that are within the watershed of the town's two reservoirs (see Figure 1-1). This includes the Mill River and Old Swamp River watersheds within Weymouth, an area of about 5450 acres, or 51 percent of the total land area of the town. The town also relies upon groundwater from five wells; however, these wells withdraw groundwater from an aquifer located within the same watersheds as the reservoirs. Thus, the study area was defined by watershed boundaries.

The overall methodology of the study included the following steps:

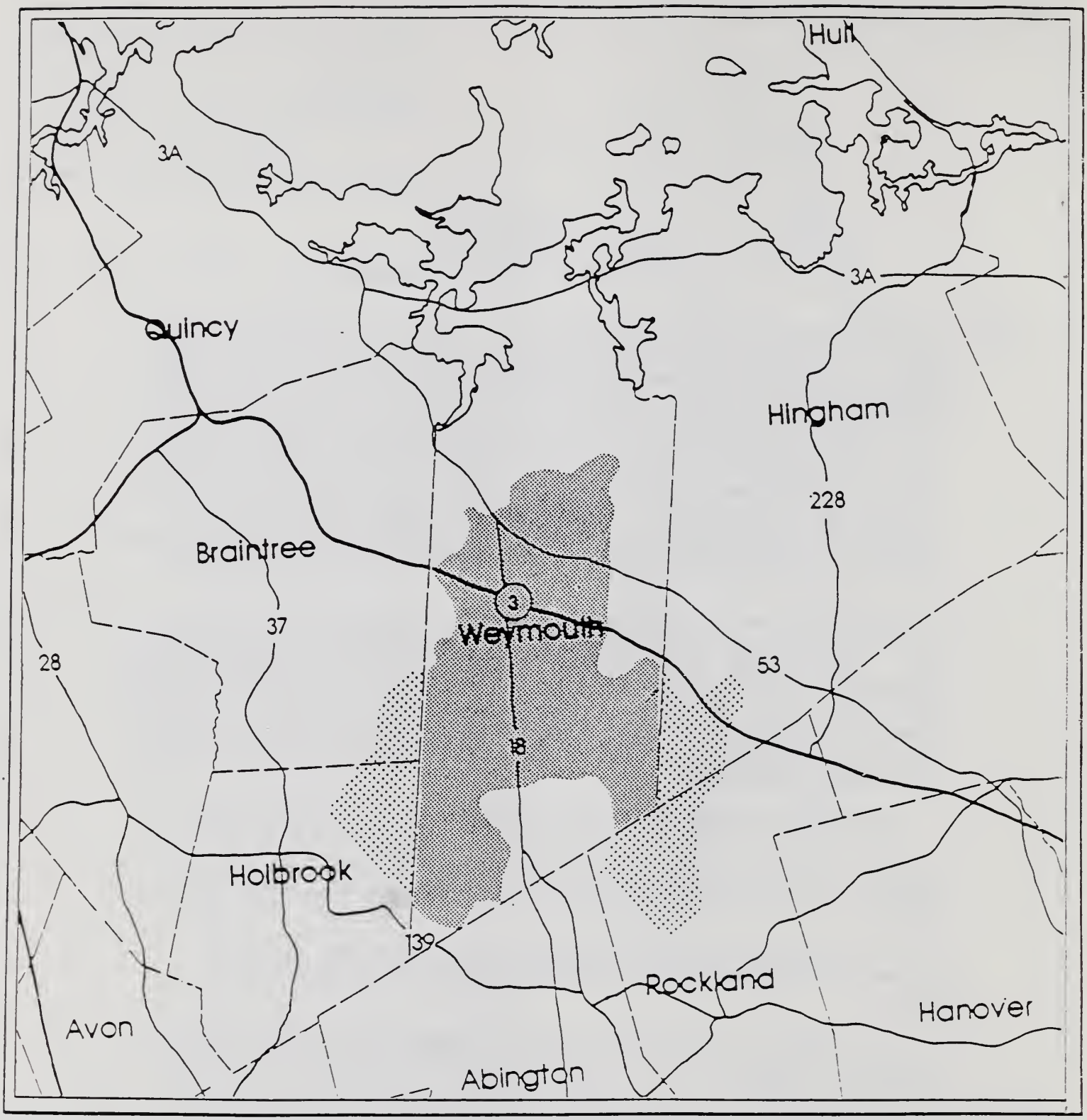
- inventory the water resources of the study area and identify areas of particular significance to the quantity and quality of the water supply

- inventory existing land uses and potential sources of contamination in the study area, and assess their threat to the water supply

- analyze the zoning of undeveloped land within the watershed and determine the extent to which new land uses with potential water supply impacts are permitted

- analyze the degree of protection afforded by existing local policies, practices, and regulations

- recomend additional water supply protection measures which can be implemented by the town



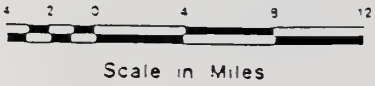


FIGURE 1-1 STUDY AREA

Watershed Area within Weymouth

Watershed Area outside Weymouth

All of the findings and recomendations were discussed and approved by a town Watershed Protection Committee, which met monthly throughout the course of the study and provided valuable information and guidance. The committee is comprised of concerned citizens and representatives of the town Conservation Commission, Board of Health, Water Division of the Department of Public Works, and Environmental Protection Committee. The Planning Director chaired the committee and served as the liaison and primary contact with the town.

Protection of water supply sources is vitally important in Weymouth because all of its drinking water comes from local sources, and there are few if any practical alternative water supply sources available to the town. Neighboring towns have experienced water supply shortages, and the Metropolitan District Commission is currently exceeding its safe yield. Weymouth's ability to remain self-sufficient in water supply may depend on how it manages existing and future development in its water supply watershed. Weymouth has a number of policies which contribute to protecting the municipal reservoirs and wells. For example:

- the location of underground fuel storage tanks and the use of road salt are restricted in the vicinity of the water supply sources

- the zoning bylaw includes a Planned Industrial Park district which controls development within the area adjacent to Whitman's Pond

- the Planning Board requires consideration of the impacts of proposed developments on surface and groundwaters

- the Conservation Commission owns large tracts of some of the most sensitive land within the watershed

This study has examined land uses and regulations in the watershed and has identified areas left unprotected, or inadequately protected, despite the existing policies. This has led to a series of recommendations for adding to and strengthening town policies and for combining them into a comprehensive program for managing activities within the watershed. The major elements of this program include:

- a Watershed Protection Zoning Overlay District which would amend the zoning bylaw within the watershed area, placing restrictions on uses with the potential to adversery affect the water supply sources

- re-zoning of certain sensitive areas within the watershed

- an Underground Fuel Storage Bylaw which would strenghten existing regulation of the location, installation, and maintenance of underground fuel tanks

- a Hazardous Materials regulation to be adopted by the Board of Health

- a Wetlands Protection Bylaw which would augument local wetlands regulation under the state Wetland Protection Act

- amendments to Board of Health regulations on the use of road salt and the application of pesticides

- modification of the practices and policies of several town departments, including closure of abandoned wells and septic systems, road salting policies, solid waste operations, earth removal and erosion control standards, identification of abandoned fuel tanks, and collection of household hazardous wastes

- public education on the effects of certain land use activities on the watershed.

- intermunicipal cooperation efforts to identify and prevent significant impacts in portions of the water supply watershed in the neighboring towns of Braintree, Holbrook, Rockland, and Hingham.

Implementation of the recommended program will require the support of several town departments, as well as general public support for new or amended bylaws. An important element for successful implementation will be public education. The committee members may assist in organizing these efforts, which may include pamphlets, a slide presentation, newspaper articles, and local cable television spots. Increasing public awareness will be as important as modifying local policies in meeting the goals of the recommended watershed protection plan.

In the chapters that follow, the background, analysis and the recommended plan are presented in detail. It is hoped that this study will assist the town in the development of a comprehensive water supply protection program.

CHAPTER 2

THE WEYMOUTH PUBLIC WATER SYSTEM: AN OVERVIEW

Prior to analyzing the existing and potential development within the recharge areas of Weymouth's drinking supply sources, known as the supply watershed, it is helpful to have a general knowledge of the elements and operation of the town's water supply system. This will aid in the subsequent evaluation of land use impacts on the watershed and in formulating a protection plan that is responsive to actual needs.*

OVERVIEW

The Water Division of Weymouth's Department of Public Works provides drinking water to approximatelyh 14,000 customers. Most of the water connections are to residential users. These include all but approximately a dozen residences in town plus a small number of Hingham households. Only 100 or so large water users are within the system. These include the South Shore Hospital, the Weymouth Naval Air Station, the schools and the larger apartment complexes as well as a small number of industries.

Since the establishment in 1885 of a public water supply system, a consistent, professional program of waterworks maintenance and expansion has been carried out. Today, the Water Division draws supplies from two surface water reservoirs and five wells, provides treatment at two separate facilities, and distributes drinking water through a total of more than 200 miles of mains. Six storage tanks and two remote pump stations comprise the major appurtenances.

Following are description of the features and operation of the water system, focusing on supply and treatment. Figure 2-1 shows the location of the system's major elements.

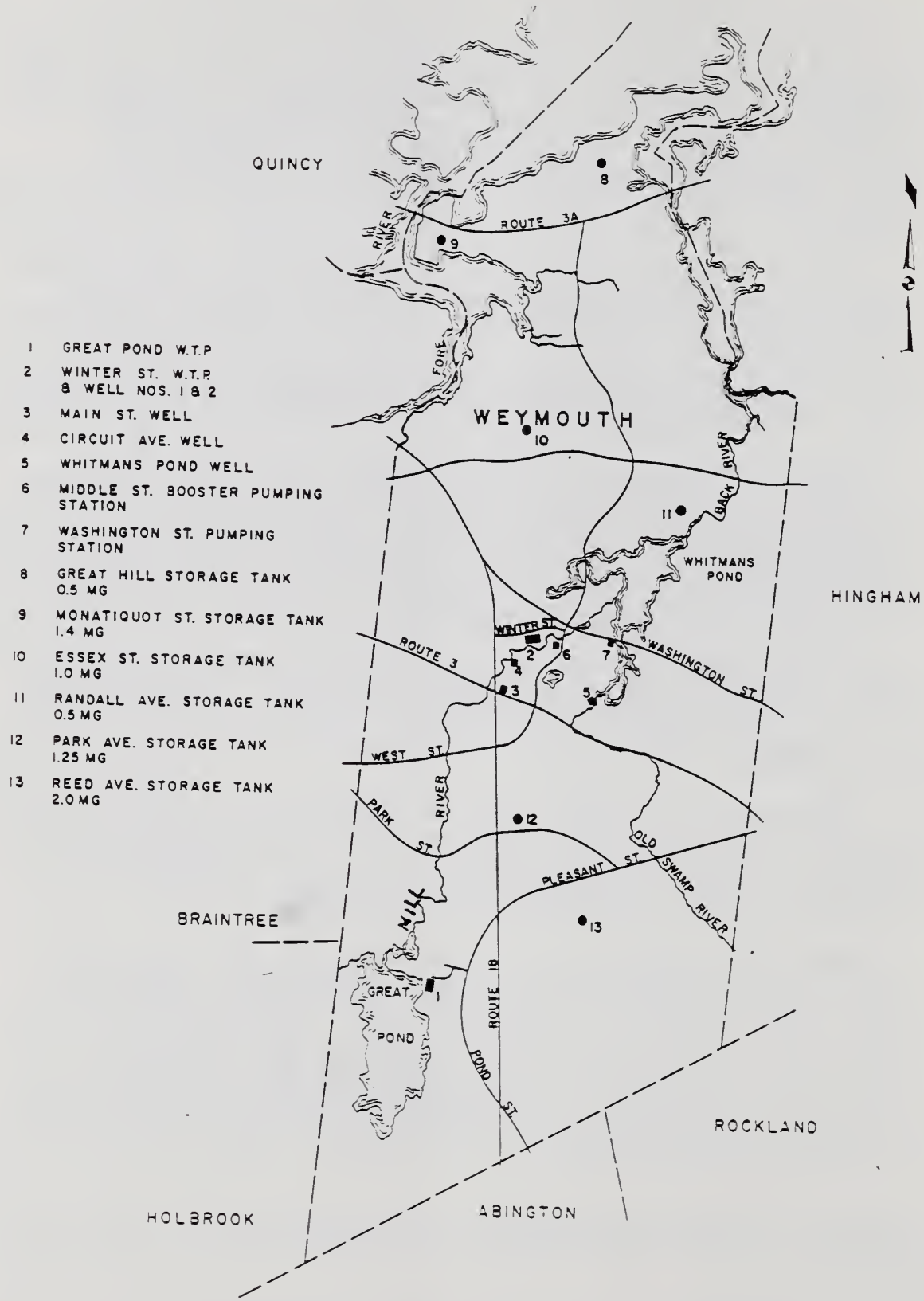
SUPPLY SOURCES

Weymouth uses both surface water and groundwater as sources of supply. The surface supply consists of impounded runoff from the watersheds of Great Pond, in the southwestern corner of town, and of Mill River and Old Swamp River, which is impounded in Whitman's Pond in the center of town. Five wells comprise the groundwater supply sources.

GREAT POND. Great Pond is the town's original public water supply source and has been used for this purpose for 100 years. The pond is about 310 acres in size; it has a total capacity of 1.01 billion gallons and a useable capacity of 0.86 billion gallons. Since 1927, when the town acquired about 150 acres around it to protect it from development, the pond has been used solely as a water supply reservoir. In 1982, Great Pond yielded an average of 2.60 million gallons per day (mgd) of water, or 61 percent of the 4.23 mgd total water supplied. Between 1979 and 1982, its average yield was 2.8 mgd.

*Appendix C reviews the development of the water system from 1820 to the present.

FIGURE 2-1 MAJOR FEATURES OF THE WATER SUPPLY SYSTEM



MAJOR FEATURES OF SUPPLY SYSTEM

WHITMAN'S POND. Whitman's Pond, the town's secondary supply source, has been part of the system since it was used to augment Great Pond's diminished capacity in the drought years of 1964 to 1966. Whitman's Pond is fed by two rivers: Mill River, which flows in a northeasterly direction from a spillway at Great Pond, and Old Swamp River, which flows generally from the southwest out of Rockland and Hingham.

Whitman's Pond covers about 180 acres; it has a total capacity of about 0.54 billion gallons and a useable capacity of 0.28 billion gallons, approximately one-third the useable capacity of Great Pond. The average yield of the pond in 1982 was 0.85 mgd, or 20 percent of the total water supplied to the community. Its average yield between 1979 and 1982 was 1.3 mgd. Besides supplying drinking water, which is treated at the Great Pond plant, Whitman's Pond provides a spawning habitat for alewives and other anadromous fish, and is a significant local recreational resource, supporting boating, swimming and fishing.

The Washington Street pump station is operated to pump water entering the pond (primarily from the Old Swamp River which enters the southern basin) to Great Pond at a rate sufficient to maintain a supply in the primary reservoir equal to the town's estimated maximum day demand. However, pumping of Whitman's Pond is currently limited, accounting for its low 1982 yield, because the intake screens of the higher velocity pumps at the Washington Street pump station become clogged with algae, attributed to pond eutrophication. Funding is currently being sought to modify the facility. The earliest the funds can be expected is in 1984.

Other measures for enhancing the water supply and recreational values of the pond are being explored in the meantime. The Whitman's Pond Association was formed recently and one of its functions will be to assist in implementing a six-year program for restoration of the pond. The program, which was recently funded by the Massachusetts Department of Environmental Quality Engineering and the town of Weymouth, includes both physical improvements and an initiative to educate the public on the effects of their activities on the pond.

GROUNDWATER. Weymouth has five municipal wells. Each is surrounded by town-owned land which was acquired at the time the wells were added to the system. An ongoing groundwater exploration program has revealed no additional well sites in the town with capacities considered reliable for municipal supply.

Whitman's Pond well, located in the Old Swamp River watershed adjacent to the pond's south cove, feeds directly into the high service system after chemical treatment for corrosion control at the site. Constructed in 1959, the well is drilled into fine sand at a depth of 42 feet. Based on actual pumping of the well during the 1964 to 1966 drought, consultants suggested the likelihood that the well is connected hydrologically to Whitman's Pond.

The other four town wells are in the Mill River watershed. These are the Circuit Avenue well, the Main Street well, and Winter Street wells no. 1 and 2. These wells, which were constructed between 1944 and 1963, are drilled into coarse sand at depths ranging from 49 to 66 feet. They are all in the general vicinity of the Department of Public Works building on Winter Street.

The actual pumping of all of the wells in the two watersheds between 1979 and 1982 averaged 0.79 mgd or 19 percent of the water supplied to the town. In 1982, the total amount supplied from groundwater sources averaged 0.77 mgd.

ADEQUACY OF SUPPLIES FOR FUTURE DEMANDS

Camp Dresser and McKee's 1979 engineering analysis of the water system conluded that the existing sources of supply would be essentially adequate to meet the town's estimated demands over a 20 to 40 year planning period during a 200 year drought. The analysis compared projected water requirements with estimated water supplies. Population and water demand projections were based on 1970 Census data and assumed future growth of the town in accordance with Weymouth's 1977 Housing Plan and existing zoning. A year 2000 average daily demand of 7.1 mgd was projected, with a maximum daily demand of 10.6 mgd. By 2020, the town was projected to require an average of 7.5 mgd and a maximum of 11.3 mgd. To meet peak demands in excess of 7.5 mgd, it was assumed that the town could use its storage capacity.

The conclusions assumed a combined safe yield of all supplies of 7.5 mgd, broken down as shown in Table 2-1.

TABLE 2-1
SAFE YIELDS OF SUPPLY SOURCES

Source	Safe Yield 200 year drought (million gallons per day)
Surface Water:	
Great Pond	2.1
Whitman's Pond	2.6
Groundwater:	
Whitman's Pond well	0
Mill River valley wells	2.8
TOTAL	

SOURCE: Camp, Dresser and McKee, Town of Weymouth Water System Update Report, August 8, 1979.

A study performed by the Massachusetts Department of Environmental Management (DEM) in 1982 updated the conclusions of Camp Dresser and McKee's 1979 study. The DEM study used 1980 Census data for its water demand projections. Because the actual 1980 population was considerably lower than that projected a decade earlier, DEM estimated a 1990 average day demand for Weymouth of 4.48 mgd and a maximum day demand of 6.95 mgd. Using the total safe yield of 7.5 mgd from the CDM study, Weymouth would have a surplus of about 3.0 mgd under normal conditions and of 0.55 mgd over the maximum day demand.

WATER TREATMENT

Weymouth provides treatment for its supply sources at two plants and by direct chemical addition at one well site.

GREAT POND WATER TREATMENT PLANT. The facility at Great Pond, which was built in 1936 and expanded 30 years later, provides rapid sand filtration for both of the town's surface water supplies. It is designed for an average flow of 4.0 mgd and has a maximum treatment capacity of 9.0 mgd. In 1982, it treated an average flow of 3.45 mgd or 80 percent of the water distributed to the town. The facility can provide treatment for contaminants such as color, turbidity and suspended solids and produce potable drinking water which meets state and federal standards for public water supplies. The finished water is also chlorinated for disinfection and receives fluoride treatment. Many chemical contaminants such as salts are not removed by the plant, nor would gasoline or organic solvents be removed if they found their way into the water supply.

WINTER STREET WATER TREATMENT PLANT. This facility was constructed in 1975 to provide treatment for removal of iron and managanese from water pumped from the four wells in the Mill River valley. It is also chlorinated and fluoridated. The treatment processes do not remove many chemical contaminants. In 1982, the plant treated an average flow of 0.77 mgd, or 18 percent of the water supplied to the town.

WHITMAN'S POND WELL. Water pumped from the Whitman's Pond well receives treatment at the site for corrosion control and disinfection. This system processed an average flow of 0.7 mgd between 1979 and 1982, and an average daily flow of 0.1 mgd in 1982 which constitutes 2 percent of the water supplied in that year.

WATER QUALITY

The water quality of the reservoirs and the wells is monitored by the Water Division of the town Department of Public Works in accordance with state and federal regulations, although some of the analytical work is done by the state and by a private certified laboratory under contract to the town. The results of this controlled sampling and analysis program show that the water is consistently within the established standards for public drinking water supplies. Table 2-2 summarizes the sampling and analysis programs carried out on Weymouth's drinking water. Town Water Divison officials would augment these routine tests if sources of contamination were discovered or suspected.

Great Pond water exhibits only natural impurities such as color and turbidity which are removed by treatment prior to distribution through the system. This is due largely to the general protection of the pond's direct drainage basin from use and development. A 1983 study on Whitman's Pond revealed that the water is polluted, to varying degrees, by phosphorus, nitrogen, chloride, iron and manganese. As discussed in the following subsections, such water quality degradation is related to the extent of developed land uses adjacent to the pond and along its tributary rivers. However, the treatment received by Whitman's Pond water at the Great Pond Water Treatment Plant is sufficient to render it safe for drinking. The quality of the groundwater in Weymouth is typical of the groundwater found in New England. Water from the municipal wells is high in iron and manganese, which are primarily aesthetic problems. However, the concentrations are reduced to a potable level by the treatment performed at the Winter Street Water Treatment Plant prior to distribution.

WATER DISTRIBUTION

The distribution system consists of transmission mains, pump stations and storage tanks. Currently, the Water Division utilizes a total of 218 miles of water distribution mains. They reach the entire town (and a small area in Hingham) with the exception of several dozen new houses constructed outside of the service area. The Water Division is involved in a phased program of expansion and rehabilitation of the distribution system. A 1982 engineering analysis found the transmission system essentially adequate under projected year 2000 demand conditions.

Weymouth's water system contains six storage tanks with a total capacity of 6.65 million gallons. Based on the most recent demand projections, the active storage volume should be sufficient to meet the town's projected year 2000 needs.

Finished water from the town's three treatment facilities is pumped through the system by 11 pumps. These were also recently evaluated and recommendations to increase pumping capacity were made. The town has added these items to its list of planned improvements.

SUMMARY

Weymouth's waterworks officials have had the foresight to implement a continuing program of evaluation and improvements to meet the growing demands for water. Review of the recent reports indicate that the town's existing supplies will provide sufficient quantities of water to meet future needs. In fact, the surplus may even come to be considered a regional resource in times of drought.

Under these generally positive circumstances, it is important not to become complacent. Since reliable supplementary supply sources have not been identified in the investigations conducted to date, it is vital that the town protect Great Pond, Whitman's Pond and the municipal wells to ensure the continuing ability of the Water Division to provide safe drinking water. The following chapters deal specifically with protection of Weymouth's water supply watershed.

TABLE 2-2
WATER QUALITY MONITORING PROGRAM

TYPE OF TEST	AUTHORITY	FREQUENCY	SAMPLING POINTS	RESPONSIBILITY FOR ANALYSIS	COMMENTS
pH, temp., chlorine residual, fluoride	DEQE/ Town	daily	2	Town, at treatment plant laboratories	Daily monitoring at two plants, fluoride sampled every two hours and analyzed once/24 hrs.
Mineral	DEQE	annual	8	DEQE, at Lawrence Experiment Station	Analyzed for 15 minerals, sediment, color, odor, turbidity, pH
Bacterial	Dept. of Public Health	weekly monthly	18 28	DGM Laboratories	Analysis under contract to town, total and fecal coliforms
Fluoride	Dept. of Public Health	monthly	2	DEQE, at Lawrence Experiment Station	One sample at each plant
Trihalomethanes	DEQE	quarterly	8	DEQE, at Lawrence Experiment Station	
Inorganic chemicals	DEQE	twice annually	3	DEQE, at Lawrence Experiment Station	At least 11 chemicals tested
Sodium	DEQE	quarterly	1	DEQE, at Lawrence Experiment Station	Used to derive annual sodium average

Source: Weymouth Department of Public Works, Water Division, 12/83

CHAPTER 3

WATERSHED AREA - DESCRIPTION OF THE NATURAL ENVIRIONMENT

This chapter describes the characteristics of the natural environment within Weymouth's water supply watershed and their significance to the drinking water supplies. The areas addressed are precipitation, topography, geology, soils and wetlands. Characteristics of the built environment are presented in Chapter 4.

WATERSHED AREA

The study area for this water supply protection study is comprised of the land within the corporate limits of the town of Weymouth that drains to the two ponds and five wells currently used as municipal water supply sources. The reasons for using the watershed boundaries as the study area boundaries are:

- they delineate the area within which land use and development activities may affect drinking water sources, making them the most meaningful geographic units by which to manage water,

- their delineation is based on topography, which is straightforward and defensible,

- for Weymouth, the aquifers into which the municipal wells are drilled fall within the boundaries of the surface water supply drainage basins, and

- over 70 percent of the water supply watershed is within the town's boundaries.

The total land area in the study area is approximately 5,450 acres; this excludes the acreage of the ponds themselves. The overall study area is comprised of subbasins as follows:

Great Pond	680 acres
Whitman's Pond	890 acres
Well area	300 acres
Other watershed area	3580 acres
TOTAL	5450 acres

As can be seen in Figure 1-1, the majority of land in Weymouth's water supply watershed is within the boundaries of the town, with about 28 percent located in the towns of Braintree, Holbrook, Rockland and Hingham.

PRECIPITATION

Weymouth's proximity to ocean waters greatly influences its climate. Precipitation averages approximately 42 inches per year including about 46 inches of snowfall. According to a 1971 engineering study, between 20 and 24 inches of precipitation per year is carried as runoff with the remainder cycled through evaporation, transpiration or recharge into groundwater. (See Appendix B for an overview of hydrologic principles).

TOPOGRAPHY

Weymouth is fairly flat, with a few scattered hills and two valleys running north and south toward Whitman's Pond and Weymouth Back River. The watershed area within Weymouth varies in elevation from about 220 feet above mean sea level (msl), in an area in the south of the town, to about 40 feet msl just northeast of Whitman's Pond. Within the watershed, the direction of surface water flow is therefore northeasterly, toward the Weymouth Back River and Hingham Bay, into the Atlantic Ocean.

GEOLOGY/AQUIFER AREAS

The geology of the area is characterized by hard crystalline bedrock lying mostly less than 50 feet below the ground surface. However, depth to bedrock varies, with some troughs and valleys up to 150 feet deep. The bedrock is generally overlain by unconsolidated (loose) glacial deposits of sand, gravel, silt and clay. Within two bedrock valleys, there are thick deposits of unconsolidated sand and gravel which are known to yield significant quantities of water. These areas known as aquifers are mapped in Figure 3-1; their area is approximately 120 acres, all within the drainage basins of the surface supply sources. Note that the municipal wells are drilled into these high yield deposits.

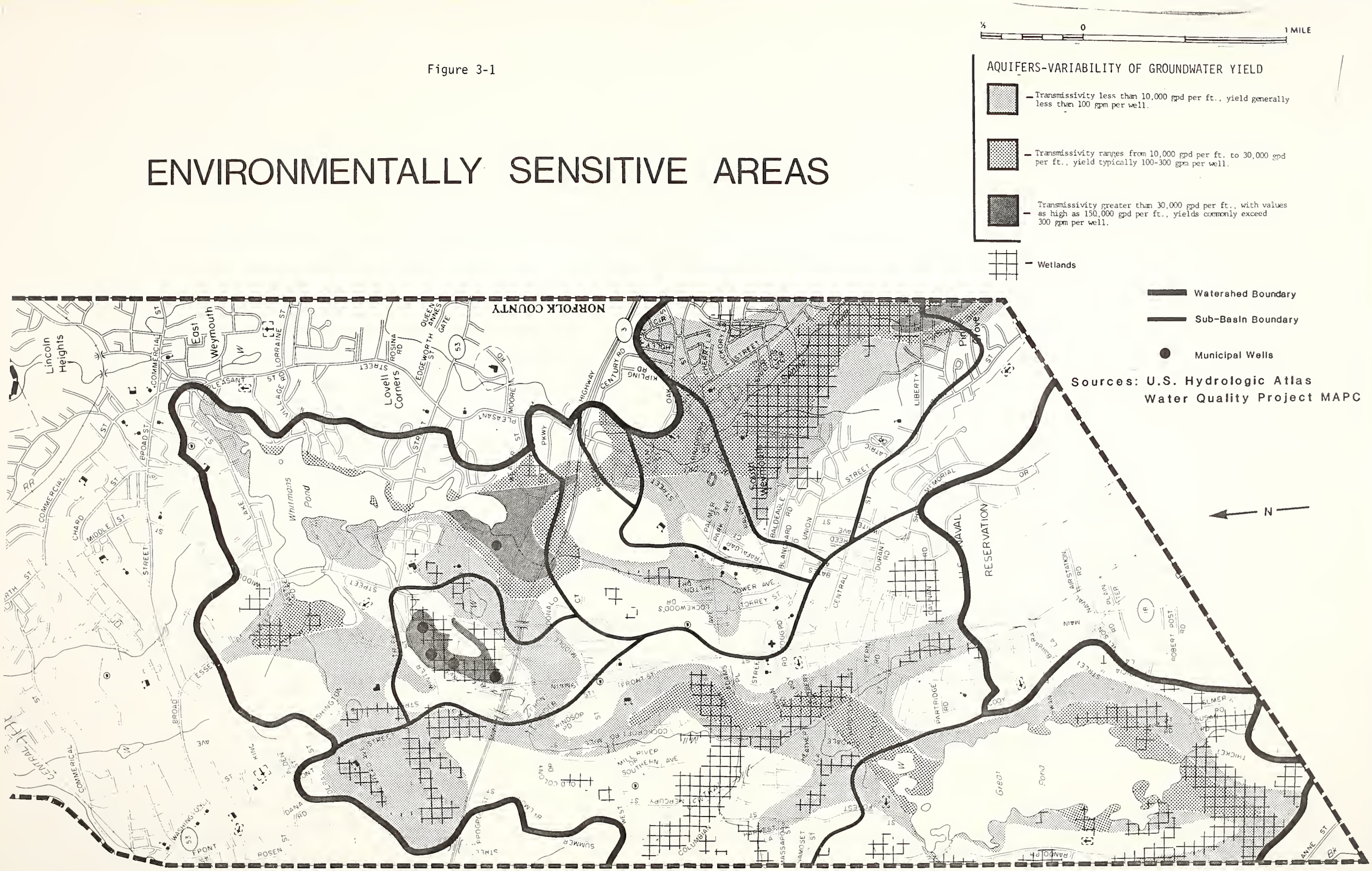
In addition to the high-yield aquifers, about 2,200 acres of less thick deposits are located in the town: about 700 acres with an estimated yield of 100 to 300 gallons per minute, and 1500 acres with less than 100 gallons per minute yield. These lower yield aquifers, which are also mapped in Figure 3-1, have less pumping capacity because of their geology as well as because of their probable hydrologic connection to the Mill River and the Old Swamp River which are the tributaries to the surface supplies. (Appendix B contains a discussion of the hydrologic connection between groundwaters and surface waters).

The figure does not show the aquifers' "recharge" areas, or the surface land that drains toward and replenishes the underground water supplies. No sources were found which have mapped aquifer recharge areas for Weymouth. However, it is certain that they lie entirely within the boundaries of the surface supply watershed, the study area for this analysis.

An extensive groundwater exploration program has been conducted by the town over many years. More than 300 test wells have been dug, but no locations of potential future municipal well sites have been revealed.

Figure 3-1

ENVIRONMENTALLY SENSITIVE AREAS



SOILS

Both Great Pond and Whitman's Pond are surrounded on three sides by soils classified as poorly drained, organic material. Moderately well and well drained stony soils comprise approximately the remainder of the direct drainage basins for the ponds. Very poorly drained organic soils are found along much of the land which drains to the Old Swamp River. Well drained and moderately well drained and gravelly soils are found over several large land areas in the generally central portion of the supply watershed.

WETLANDS

Wetlands are low-lying, transitional areas between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water. Wetland areas have several unique functions and values with respect to water supplies: they filter pollutants entering streams, provide temporary storage for flood control, supply base flows for streams and rivers, and supply water to the surface system in periods of limited rainfall.

Weymouth's supply watershed includes some extensive wetland areas totalling about 950 acres in all, or approximately 17 percent of the land area in the watershed. Wetland areas are delineated in Figure 3-1. Most are small areas less than 20 acres in size, but 3 individual areas are larger than 150 acres each. These are located along the southern end of Great Pond; along the Old Swamp River; and along a portion of Mill River, westward, generally adjacent to Columbian Street.

Development in wetlands is regulated by the local Conservation Commission in accordance with the provisions of the Massachusetts Wetlands Protection Act (Massachusetts General Laws, Chapter 131, Section 40).

CHAPTER 4

LAND USES AND WATER SUPPLIES

This chapter describes the uses of the land in the water supply watershed and examines the effect of the land uses on the supply sources of the town. After a brief review of the recent development trends of the town, the majority of the chapter addresses land use/water supply relationships in terms of individual potential contaminants.

WEYMOUTH'S HISTORIC DEVELOPMENT TRENDS

This section reviews the last 30 years of development in Weymouth. The perspective aids in understanding the existing land uses, as it provides information on some past activities which today may affect the supply sources.

The data on historic land use was taken from a 1974 study by William MacConnell at the University of Massachusetts at Amherst who classified and mapped land uses by interpretation of aerial photography. The minimum parcel size mapped and classified was 3 acres of land. The MacConnell study analyzed land use changes from 1951 to 1971. Table 4-1 summarizes the population and population density of Weymouth between 1950 and 1970.

TABLE 4-1
POPULATION DATA, 1950 - 1970

Year	Population	Population Density (per sq.mi.)*
1950	32,690	1815
1960	48,177	2675
1970	54,610	3032

*Town is 17.5 square miles in size; excluding the islands

The data show that the rate of increase in population between 1950 and 1960 was 47 percent; which dropped to 13 percent in the next decade. The overall growth rate between 1950 and 1970 was 67 percent. In 1970, Weymouth was the third most densely developed community in the county. That year, the town was twice as densely developed as the average county density of 1,483 persons per square mile.

Table 4-2 shows the breakdown of land uses for 1951 and 1971. Of note is the loss of 9 percent of forested land and 67 percent of agricultural land during the same period in which transportation uses increased by more than 400 percent, and commercial/industrial and residential used increased by 13 percent and 11 percent respectively. During this period, residential land became the most predominant single use; taking the place of forested land.

TABLE 4-2
LAND USES, 1951 and 1971

Use	1951, Acres	1971, Acres	Percent change, 1951-1971
Forest	4635	4219	-9
Wetland*	1374	1148	-16
Agriculture	748	245	-67
Open/Public	400	437	+ 9
Outdoor rec	not included	162	-
Indus./Comm	381	430	+13
Residential	3923	4364	+11
Transport.	67	356	+431
Mining/Waste	not included	167	-

*Wetland includes ponds and streams as well as marshes, bogs, etc.

NOTE: The current study uses a different land use classification and the MacConnell data are not directly comparable.

Figure 4-1, which is based on the same data, shows the percentages of the different uses and illustrates the changes between 1951 and 1971. In all, "urban" uses (Industrial/Commercial, Residential, Transportation) increased by 7 percentage points while "non-urban" uses (Forest, Wetland, Agriculture) decreased by 11 percentage points. The figure also shows clearly the predominance of residential uses among the developed land uses.

SUMMARY OF EXISTING LAND USE

The current land uses within the water supply watershed have been classified for analysis and mapped in Figure 4-2. A chart illustrating the percentage of each use in the study area is shown in Figure 4-3. As is evident; Weymouth's trend from the 1950's toward development of residential land has continued. Only small increases in industrial and commercial development have occurred since the MacConnell study. However, there is still a sizable percentage of open/conservation/recreation property in the town.

LAND USE/WATER SUPPLY RELATIONSHIP - POTENTIAL CONTAMINANTS

Land uses within the water supply watershed can affect both water quality and water quantity through physical alteration of the environment, which changes drainage patterns and rates of runoff and recharge, and through discharge of contaminants to surface or groundwater. In this chapter, the potential impacts of land uses on water supplies are analyzed in terms of the physical alterations and chemical contaminants associated with each. For each of these potential sources of contamination, the analysis presents:

Figure 4-1 WEYMOUTH LAND USE CHANGE 1951-1971

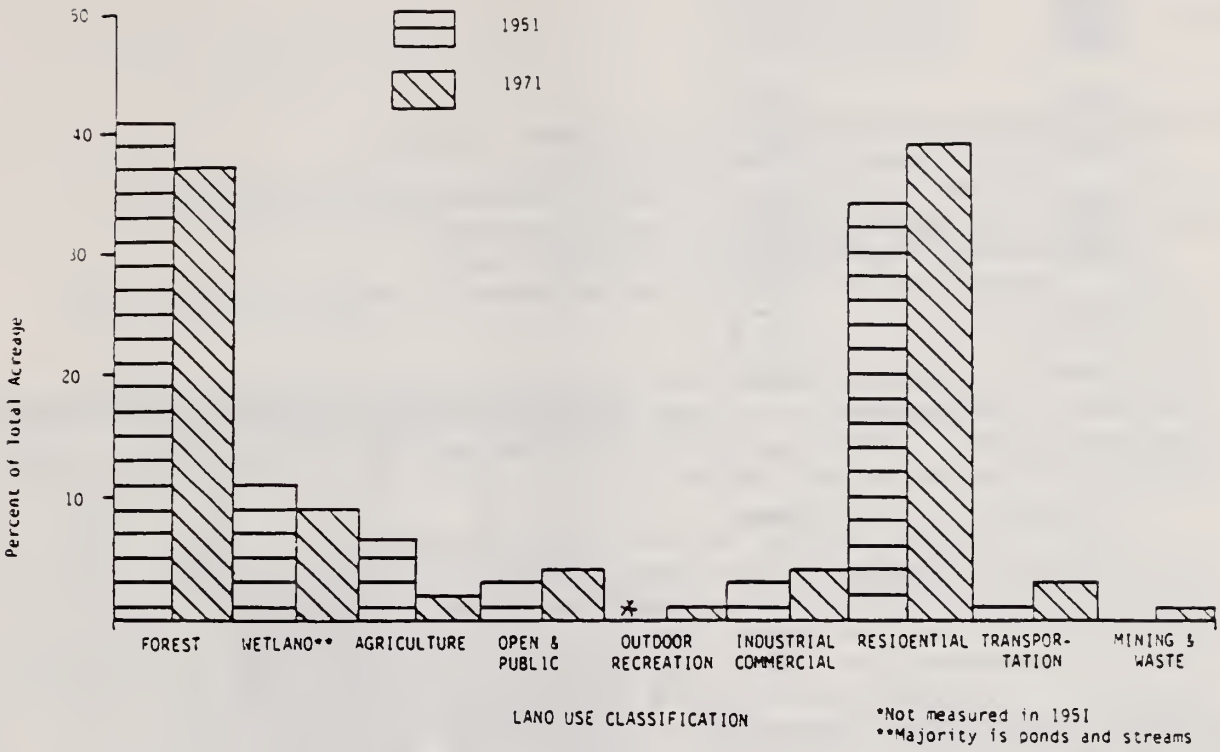
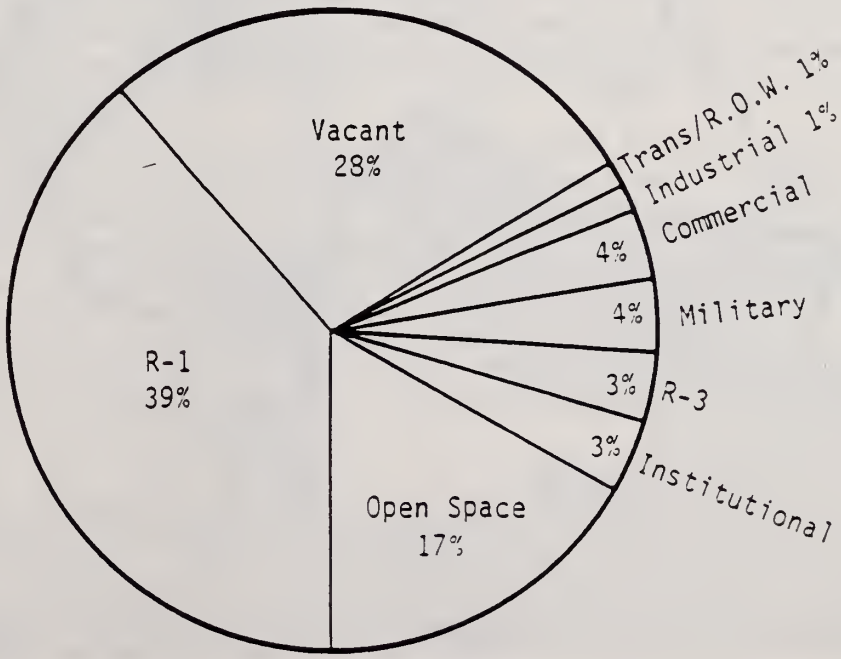


Figure 4-3 WEYMOUTH EXISTING LAND USES



- the characteristics and water supply impacts,
- the land uses associated with each,
- existing conditions in Weymouth describing the prevalence of these land uses within the water supply watershed,
- existing regulations and practices; and
- recommendations for improved management or regulation for water supply protection.

The potential sources of contamination addressed are: runoff and erosion, wastewater, underground fuel storage tanks, road salts, leachate, hazardous wastes, pesticides, fertilizers, surface waste impoundments, and abandoned wells and septic systems.

As can be seen in Figures 4-2 and 4-3, approximately 17 percent of the study area is classified as open space. This classification includes conservation land, town-owned buffer areas around supply sources, land used for recreation, and cemeteries. An additional 28 percent of the watershed is vacant land, which includes privately-owned undeveloped land which may be developed in the future (See Chapter 5-Zoning). Such primarily undeveloped property provides a natural recharge area for groundwater and surface water and thus has no existing adverse effect on either the quantity or quality of drinking water supplies. The developed land uses in the remaining 55 percent of the watershed have the potential to cause impacts on the quantity and quality of water supply in Weymouth. These impacts are described in the remainder of this chapter.

Runoff and Erosion

a. Characteristics and Water Supply Impacts. Runoff is rainfall that is prevented from infiltrating soils and recharging groundwater by impermeable surfaces. Runoff flows over surfaces, picking up contaminants such as road grit, salts, fertilizers, pesticides, and oils, and is discharged to ponds, streams or wetlands either directly or through a system of storm drains.

Erosion results when the earth is left bare during or after construction or as a result of agricultural activities. Steep slopes and stream banks can also erode if they are not adequately vegetated. Soils can be washed away by runoff and suspended in the waters of lakes, ponds or streams causing turbidity. When suspended soil particles finally settle, fine-grained silt deposits may seal off the bottom of a water body and eliminate the natural process of groundwater exchange. Pollution of waterbodies by runoff and erosion is called "non-point source pollution" and has become widely recognized as a major cause of water quality degradation.

b. Land Use Associations. All land use categories except open space have the potential to affect water supplies through runoff and erosion. The severity of impact is related to the general intensity of development. Developed, or urbanized, land uses tend to have high runoff rates and create the potential for contamination by runoff, while construction activity itself creates the potential for erosion.

Figure 4-2

LAND USE

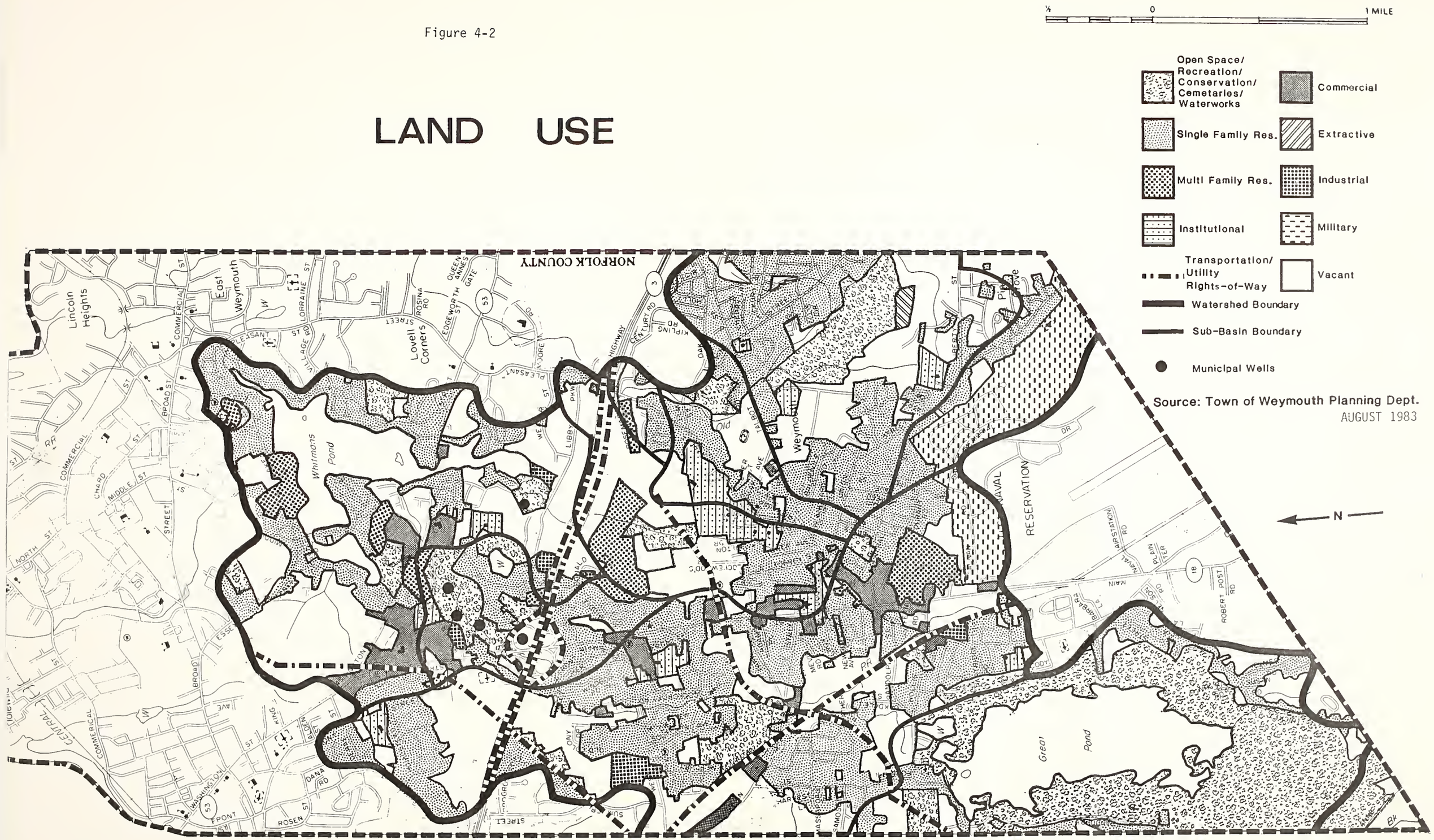


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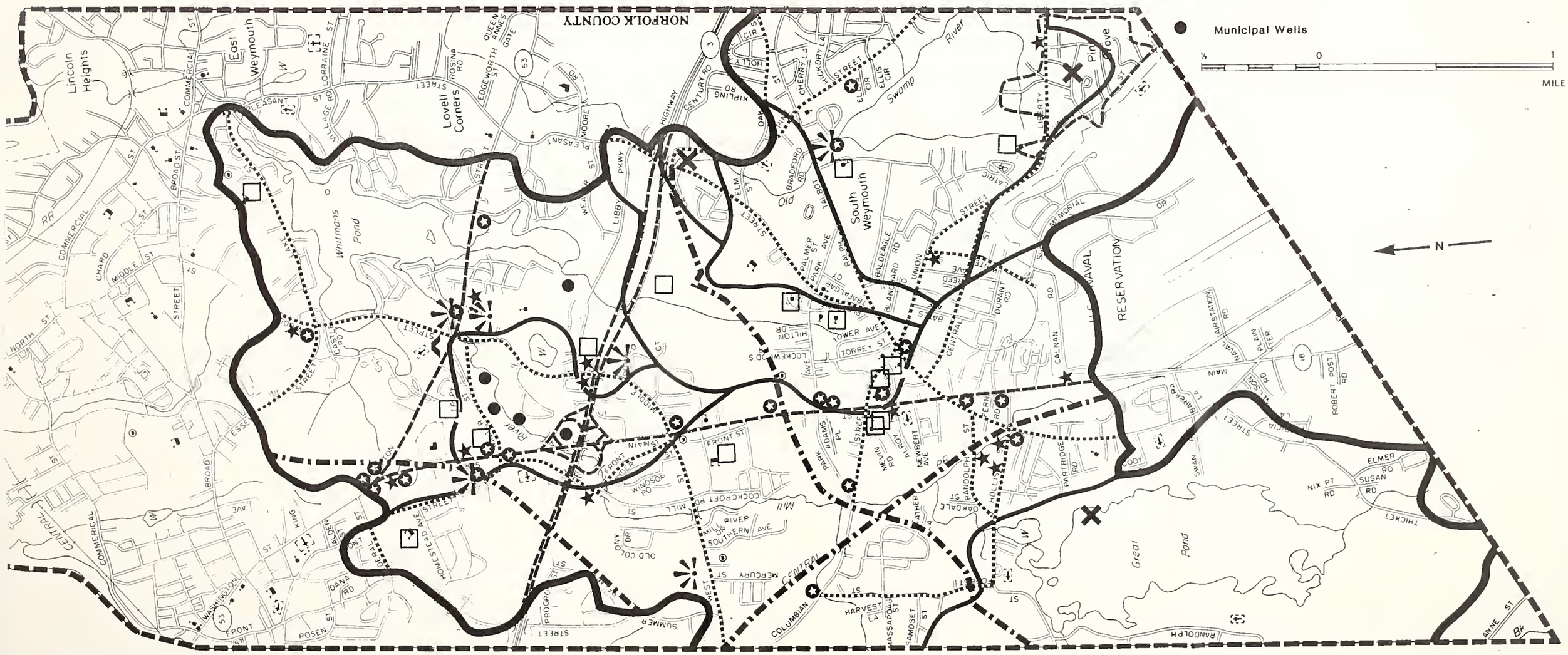
Figure 4-4

POTENTIAL SOURCES OF WATER SUPPLY CONTAMINATION



c. Existing Conditions. Approximately 55 percent of Weymouth's watershed area is developed (Figures 4-2 and 4-3). Of this total, about 40 percent is developed as single family homes and the remainder contains more intensive uses such as multi-family residential (apartments), institutional (schools, hospitals and churches), commercial (retail or business establishments), and industrial.

Runoff from developed areas in the water supply watershed outside of the town is also of concern. For example, the existing South Shore Industrial Park in Hingham and the proposed industrial development on the Braintree/Weymouth border may pose threats to Weymouth's drinking water supplies. Although runoff and erosion generally do not represent as serious a threat to water supplies as other sources of contamination, the extent of developed land within the watershed creates a situation in which the two ponds, primarily Whitman's Pond, are vulnerable to a wide range of land use activities. In addition, significant portions of the watershed area have yet to be developed.

d. Existing Regulations and Practices. A number of local provisions are currently in place which can minimize water supply degradation due to runoff and erosion. (The local control mechanisms for all of the potential contaminants addressed here are summarized in Chapter 6.)

o Earth Removal: in accordance with Article XIX of the Zoning Bylaw, all earth removal requires a special permit from the Board of Zoning Appeals except if the work is in conjunction with construction of a facility that has received other permits or review by the Appeals or the Planning Board (see other town review requirements below). The bylaw gives the Board of Appeals authority to impose conditions regarding steepness of final slopes, loam replacement, plantings, and temporary and permanent drainage among other things. If the project has undergone other reviews, the Building Inspector may issue the Special Permit.

o Earth Filling: Article XX of the Zoning Bylaw requires a special permit from the Building Inspector for all filling except if the total volume is less than 50 cubic yards or if the filling is in conjunction with construction that has received other reviews or permits by the town. Among other things, this article provides authority to stipulate slope stabilization measures to prevent erosion and control runoff. In cases where the Conservation Commission has issued an Order of Conditions, the Special Permit is contingent upon compliance of the proposed action with the orders.

o Subdivision Regulations, Environmental Impact Statement: the town's subdivision regulations include a requirement for preparation of an "environmental impact statement" for subdivisions which contain more than 9 one- or two-family residences, for all multiple family developments, and for all non-residential subdivisions. The environmental impact statement is to address impacts of runoff and erosion and the effect of the development on public water supply sources.

o Special Permit Assessment: the Planning Board's Special Permit review procedures require consideration of the effect of stormwater runoff from the proposed action on adjacent and downstream surface water bodies and on groundwater.

o Massachusetts Wetlands Protection Act: the Conservation Commission reviews permit applications called Notices of Intent which are submitted by all developers who propose alteration of wetlands. The Commissioners have authority to require runoff and erosion control measures in their Orders of Conditions for the purpose of preventing water quality degradation.

e. Recommendations. The existing regulations in the town give fairly broad powers to a number of boards for control of runoff and erosion. Given the percentage of undeveloped land in the watershed area, it will be important to continue to enforce the existing regulations. To this end, it would be useful to standardize the criteria for acceptance of plans among the responsible boards. It is also advisable that the performance standards for earth removal are increased.

In addition, current development plans outside of the town but within the water supply watershed area (Braintree, Rockland and Hingham) highlight the need to establish a cooperative relationship for reviewing upcoming projects in those neighboring towns.

Wastewater

a. Characteristics and Water Supply Impacts. Both surface water and groundwater supplies can be affected by problems associated with disposal of sanitary wastes. Three types of problems are addressed here: failing septic systems, sanitary sewer overflows and "NPDES" discharges.

Failing septic systems can be due to improper siting, installation or maintenance. Soil type, depth to bedrock and depth to the water table can be major factors in septic system failures. Such failure can introduce excessive nutrients, chlorides, bacteria and household chemicals into soils which can then leach into water supplies. According to DEQE, septic systems on lots less than 40,000 square feet in area have the potential to contaminate groundwater.

Overflows of sanitary sewers during storms can enter surface waters, either directly or by way of storm drains. One other effect of sewer installation is depleted watershed recharge by transporting the wastewaters outside of the water supply watershed to other locations for ultimate disposal.

b. Land Use Associations. Residential, commercial, institutional and industrial uses generate sanitary wastes (see Figures 4-2 and 4-3). Problems associated with failing septic systems may occur in unsewered areas, and sewer overflows may occur in the areas of the town that are sewered.

c. Existing Conditions. The Sewer Division of the town Department of Public Works has been responsible for sewer installation in about 98 percent of the town's developed areas. There are separate systems for the collection of sanitary flows and storm flows. About 11,000 sanitary connections currently exist in the town. This includes wastes generated at the light industrial and commercial establishments, such as hairdressers and dry cleaners. The local sanitary collection system connects to the Metropolitan District Commission system which conveys the wastewater to the Nut Island Water Pollution Control Plant in Quincy for treatment and eventual discharge into Boston Harbor.

Some dischargers remain unconnected to the system, however, and continue to use on-lot disposal such as septic tanks and cesspools. The largest unsewered section of the town is the sparcely-settled area off Union and Liberty Streets. This area is shown in Figure 4-4, which also shows other potential sources of contamination. Also, a small number of residences adjacent to Whitman's Pond are not yet sewered because the area is built on ledge which creates the need for difficult and expensive construction techniques. In addition, about 30 percent of the developed uses (town-wide) have not tied in to available sewers. These unconnected sewage generators are spread fairly evenly throughout the town which means that there may be about 4,800 of these active on-lot systems remaining in the study area.* In addition, about 12 new septic systems per year are permitted under a variance procedure in areas where sewers are not available.

Other causes of contamination may be associated with the areas of the town that are sewered. Under storm conditions, the town's Central and South Weymouth Main Sewer often overflows in a number of areas. The overflow within the study area is in the vicinity of Pine and Pleasant Streets (see Figure 4-4). The primary cause of overflows is known as inflow. Inflow is extraneous, basically clean-water flow in sanitary sewers from such above-ground sources as illegal connections (house fixtures used to pump flooded basements, and roof leaders) and leaking manhole covers. These combine to generate flows in excess of the design capacity of the sanitary sewers which consequently overflow into streets and yards during storms. Sewer overflows ultimately reach streams and ponds by way of surface runoff.

As new sewer connections are made in conjunction with continued development, the possibilty of sewer overflows is likely to increased due to the greater sanitary flows combined with the increased number of potential illegal connections. Continued overflows may also increase as the system ages and pipes and joints crack, allowing infiltration of groundwater into the sanitary sewers. The primary impact on drinking waters of sewer overflows is an increase in the cost of community water treatment to remove bacteria. Also, overflows result in the addition of relatively small concentrations of household chemicals to the water supplies.

*Assumes 16,000 generators; and 50 percent of the town in the study area.

There are two facilities in the study area which are currently under state permit to discharge "wastes" to water bodies in accordance with the National Pollutant Discharge Elimination System (NPDES) program. One is the Great Pond water treatment facility which has a permit to discharge from the plant's sludge lagoon back to the pond. The other is a permit to discharge noncontact cooling water into surface lagoons from the Merriman Division of Litton Industries. This company manufactures metal products for tools and is located in the South Shore Industrial Park in Hingham. According to the State Department of Environmental Quality Engineering, Merriman has applied for a permit to operate this surface waste disposal facility in accordance with the new Massachusetts Groundwater Discharge Permit Program (see section on Surface Waste Impoundments). No adverse impact on drinking water is likely to be associated with the two existing NPDES discharges in the study area.

d. Existing Regulations and Practices.

o New facilities connections: all new developments must connect to an available sewer. The Board of Health may allow variances to this requirement in cases where the distance to a sewer line is more than 600 feet or the cost of connecting to the sewer is more than $2000. In such cases, an on-site disposal system may be permitted if the requirements of the state sanitary code are met. Discharges of more than 1500 gallons per day also require state approval.

o Existing facilities connections: Section 5 of the Weymouth Plumbing Rules and Regulations states that "all buildings with plumbing fixtures shall be connected to the sewer within two years after the sewer is available unless sooner ordered by the Board of Health." However, because of the financial constraint that this places on residents, town officials have not enforced the time limit stipulation. Therefore, these on-lot systems are likely to remain operational until they begin to experience problems. However, the town will be informed of defective on-lot systems and enact the tie-in regulations as operational problems occur, since they require a Board of Health permit to repair.

o Planned Industrial Park (PIP) zoning district: Article X of the Zoning Bylaw, which regulates development in the PIP districts, requires that all industrial developments located there discharge to sewers.

o Subdivision Regulations, Environmental Impact Statement: the town's subdivision regulations require developers to submit an environmental impact statement with Definitive Plans. The environmental evaluation is to include information on sewage generation and disposal. Developers are also encouraged to coordinate with the Department of Public Works and the Board of Health.

o Special Permit and Site Plan Review procedures: these require that site plans delineate waste disposal systems and that special permit applications include Special Permit Assessments including a discussion of the adequacy of proposed methods for disposal of sewage.

o The National Pollutant Discharge Elimination System: this Federal program establishes a permitting system for direct discharges to water bodies and requires that the effluent be within individually-specified water quality criteria for the protection of the receiving waterbody.

e. Recommendations. In general, although property owners should be encouraged to tie in to available sewers, the majority of the remaining on-lot systems are not likely to contaminate drinking water supplies because of the ability of the town to require sewer connection in cases where problems are experienced. However, the proximity of the remaining unsewered area to the Old Swamp River, coupled with the development potential of the area, indicate the need for sewer construction in the future. These sewers are currently under design, however construction plans are uncertain at this time. In addition, money should be budgeted to construct the already-designed sewers in the remaining streets near Whitman's Pond. Until sewers are available, variances for on-lot disposal systems should only be permitted for single-family and duplex residential uses in the watershed area.

Information programs to alert residents to the effects of inflow may help to reduce problems with wastewater overflows. The Whitman's Pond Association is implementing a public information program which may contribute to education provided as a result of this study. Continued maintenance of the sewer system, including replacement of broken manhole covers, would contribute to reducing the inflow problem. Also, in cooperation with the MDC, the town should identify sources of I/I and initiate a program to reduce all of these excess flows. In addition, the Planning Board should continue to consider sewer capacity in its development decisions. Continued enforcement of all of the town's regulations and policies will minimize the potential for contamination of drinking water from wastewater sources.

Underground Fuel Tanks

a. Characteristics and Water Supply Impacts. Leaking subsurface storage tanks can be due to corrosion or puncture. If the tanks contain gasoline or other fuels, contamination of groundwater supplies can result. The presence in a water supply watershed of abandoned tanks or of steel tanks, which were prevalent but have an average life span of only about 20 years in corrosive soils, indicates a greater degree of vulnerability for the supplies. Gasoline leaks have been identified by the Environmental Protection Agency as a major threat to water supplies. EPA estimates that there are up to 100,000 leaking storage tanks nationwide releasing about 11 million gallons of gasoline annually into the ground. The problem has also been recognized by the American Petroleum Institute.

Weymouth's one experience with contamination and temporary loss of a supply source was due to a gasoline leak. The town was unable to use water from the Main Street well for a period of five years in the early 1970's because it was contaminated by gasoline that leaked from a nearby gas station's underground storage tank. Extended pumping of the aquifer reduced the concentration of hydrocarbons to a level that now allows the water to be used for supply after aeration and treatment at the Winter Street Water Treatment Plant.

b. Land Use Associations. Underground storage tanks are typically located at service stations, fuel companies, highway department garages, car dealerships, garages for commercial car and truck fleets, schools, churches, large apartments, hospitals and other institutions, and at residences when large heating oil tanks are desired for additional storage capacity. The associated land uses shown in Figures 4-2 and 4-3 are therefore industrial, commercial, institutional and multi-family residential.

c. Existing Conditions. Approximately 10 percent of the watershed area is currently developed for these critical uses. Figure 4-4 shows the locations of some of the underground tanks in the study area. These include tanks licensed by the Board of Selectmen as well as the largest of the home heating oil tanks, which receive permits by the Fire Department. Most of these are made of steel. The majority of the licensed tanks are believed to be underground and used for gasoline storage; a minority store waste oils, printing fluids, paint napthas, and antifreeze.

Table 4-3 shows the ages and sizes of the additional 540 smaller underground home heating oil tanks which have received Fire Department permits town-wide. More than 200 are older than 20 years. Because of the large number, those in the study area are not mapped. However, based on the percentage of the town included in the water supply watershed, 250 to 275 unmapped underground heating oil storage tanks may be expected to be located in the study area.

TABLE 4-3
Number of Underground Heating Oil
Storage Tanks, Town-wide

Age (years)	Size (gallons) 275-600	1,000-2,500	3,000-6,800	10,000-15,000	Total
0-10	79	50(c)	11	10	150
11-20	119	40	12	1	172
21-30	51	46(d)	17	5	119
31-40	65(a)	20(e)	7	2(f)	94
41-50	3(b)	2	0	0	5
Total:	317	158	47	18	540

Source: Town of Weymouth Fire Dept., Oil Burner Permits, 10/83

Notes:
A. Includes 1-110 gallon tank
B. Includes 1-55 gallon tank
C. Includes 1-750 gallon tank
D. Includes 1-850 gallon tank
E. Includes 1-800 gallon tank
F. Includes 1-35,000 gallon tank

Large tanks are primarily for schools and churches.
Tabulation excludes tanks for which information on size or age is unavailable, ie 5-10 percent of all above and below ground tanks.
Tabulation includes tanks which may have been removed.

With respect to abandoned tanks, the Fire Department requires removal and proper disposal of tanks licensed by the Board of Selectmen, and none of this type is likely to be in the town at present. However, the older underground home heating oil tanks which were allowed by Fire Department permit are not monitored and some may be abandoned.

The number and age of underground fuel storage tanks currently located within the water supply watershed create a significant threat to the drinking water supplies of the town. In addition, since most land uses have some potential to be associated with use of underground fuel tanks, there are likely to be many opportunities for their installation with future developments.

d. Existing Regulations and Policies.

o Massachusetts Board of Fire Prevention Regulations: Part 527, Section 9.06 of the state regulations sets up rules for design and testing of underground fuel storage tanks for protection of water supplies.

o Part 527, Section 5.05 of the regulations contains a requirement for leak detection measures including monitoring and inventory record keeping. The section also requires notification of the local Fire Department in the event of a leak.

o Section 10.12 of the same part includes a requirement that the holder of any license for underground storage of flammable fluids notify the local fire department if he plans to abandon use of the tank. Upon notification, the fire department will require removal of the product from the tank, proper capping of openings, and removal of the tank from the ground.

o These licenses to store flammable fluids are issued in Weymouth by the Board of Selectmen. The Fire Department holds responsibility for issuing permits for storage of tanks with capacities less than 10,000 gallons which will be used to heat buildings. However, the Fire Department reviews all applications for licenses and permits. Among the criteria used for review are instructions from the town Department of Public Works not to allow installation of these facilities within 100 feet of Whitman's Pond, Mill River or Old Swamp River, or within 400 feet of the town wells or Great Pond. This has been a working policy since 1974, although it is not formalized in a bylaw or a regulation.

The Department can reject an application or can impose stipulations for granting of the permit or license. Such stipulations may require vault enclosures or use of corrosion or puncture resistant or double-lined tanks.

o Massachusetts Wetlands Protection Act: the Conservation Commission has authority to regulate installation of underground tanks in wetland areas. It can order that they be contained, for example, in vaults, or that corrosion or leak resistant tanks be used.

o Weymouth Article X, Zoning Bylaw, Planned Industrial Park District: this district, which includes that portion of the Libbey Industrial Park adjacent to Whitman's Pond, requires a special permit for storage of napthas (solvents) both above and below ground. Applicants must include a statement on potential water supply effects to obtain a permit.

e. Recommendations. Aging underground fuel tanks represent a serious threat to the quality of water supplies in the town. Although the Fire Department's ability to review and approve applications for flammable fluids licenses is a fairly powerful protection tool, a number of measures should be taken. The Fire Department should continue to exercise its authority to require use of corrosion and puncture-resistant tanks and to regulate installation methods. Information regarding the limits of the watershed and aquifer area should be provided to the Fire Department to be used in review of applications for licenses and permits.

In addition, local control should be formalized by adopting a town underground fuel storage tanks bylaw which will provide greater authority to the Fire Department. By requiring specific prohibitions and practices, the town can retain direct control of this land use activity. Elements of the bylaw should include required registration, monitoring and leak detection systems, spill contingency plans and penalties for violations.

The bylaw can be administered by the Fire Department with only minor modifications to its current review and record-keeping practices. While the primary purpose of these restrictions is to promote fire safety, it is important to recognize that protection of water supplies is an associated benefit.

In addition, as time and personnel constraints permit, the Fire Department should begin a program to identify and remove abandoned permitted underground fuel tanks, since these are more numerous than the licensed tanks. Further control over underground storage tanks may be achieved through the provisions of a recommended Board of Health regulation for hazardous materials (see subsequent discussion).

Road Salts

a. Characteristics and Water Supply Impacts: Deicing chemicals such as sodium chloride applied to roads in winter or stored in uncovered piles can wash off pavements into surface water bodies or percolate through soils to groundwaters. Since standard water treatment systems are unable to remove sodium from drinking water, sodium concentrations which may be harmful to the health of some individuals may result. Also, at high concentrations, sodium can corrode water distribution pipes and water fixtures. Therefore, the Massachusetts Department of Environmental Quality Engineering has set a health standard of 20 mg/l for sodium. DEQE requires regular sampling and analysis of sodium concentrations in public water supplies and notification of customers if the concentrations exceed the standard.

b. Land Use Associations. Land uses, shown in Figures 4-2 and 4-3, which are associated with use of road salts are transportation, for maintaining road safety in the winter, and residential, institutional, commercial and industrial for clearing parking lots and private drives.

c. Existing Conditions. Approximately 50 percent of the study area contains land uses associated with road salting. Specifically, Figure 4-4 identifies the streets in the water supply watershed which receive salt applications. The state Department of Public Works uses road salt on Routes 3, 53 (Washington Street), and 18 (Main Street). They use 100 percent salt in their applications because their policy is to achieve bare pavements as quickly as possible after storms. The rate of application by the state is 300 pounds per lane-mile, and the state maintains about 25 lane-miles of roadway in the study area.

The Weymouth DPW Highway Division also salts about 20 miles of local streets. The town uses significantly smaller concentrations of road salt than the state does, at a salt/sand ratio of approximately 1:12, which is just enough salt to keep the sand from freezing. The road salt is stored on the town Department of Public Works property on Winter Street in a covered and enclosed shed built by the state.

Sodium concentrations in Weymouth's drinking water have been above the state health standard for a number of years. In 1983, the annual average was 46 mg/l; in 1982, the average was 39 mg/l; and it was 31 mg/l in 1981. Furthermore, the water quality analyses reveal that the concentrations are higher during and after the winter months than they are at other times of the year. In addition, the Main Street and the Winter Street wells have had higher concentrations than the other supply sources. This is probably due to salt applications on Route 3 and on Winter Street; the Main Street well is located in a cloverleaf of the highway and runoff from Winter Street drains directly to the town wellfield.

d. Existing Regulations and Practices.

o Board of Health Regulation No. 7: this regulation prohibits the application of deicing chemicals, even if mixed with sand, in private developments within the water supply watershed. The policy is implemented with the cooperation of the Department of Public Works and the State DEQE.

o Avoidance of sensitive areas: the Highway Division of the Department of Public Works implements a general policy to avoid salt applications in the vicinity of Great Pond, Whitman's Pond, and the Whitman's Pond well.

o Wetlands Protection Act: this act grants authority to the town Conservation Commission to minimize harm to wetlands by issuing Orders of Conditions which, among other things, may prohibit use of sodium chloride in subdivisions that drain to wetlands.

e. Recommendations. The town may be able to reduce sodium concentrations somewhat by strengthening the existing local program of restricted use of road salts. This could be done by limiting use of road salt over a larger area of the watershed than is currently restricted; especially in the immediate vicinity of the supply sources. Use of road deicing chemicals other than sodium chloride should also be considered.

With respect to the town road salt regulation governing use of deicing chemicals in private developments, the town should specify in the regulation the boundaries of the water supply watershed which can then be used to delineate the jurisdiction of the regulation.

Leachate

a. Characteristics and Water Supply Impacts. Leachate is liquid waste which results when water percolates through buried materials in sanitary landfills and other disposal sites. Depending on the characteristics of the buried materials, leachate can contain inorganic and organic contaminants, as well as dissolved solids which can degrade municipal groundwater and surface water supplies.

b. Land Use Associations. Land uses which may be associated with leachate generation are classified as disposal, industrial and commercial. Disposal uses include sanitary landfills and other official dump sites. Industrial and commercial establishments are included because owners may bury wastes from the operations on their property. (Also see section on Hazardous Wastes).

c. Existing Conditions. In Weymouth, the sanitary landfill, which is located outside of the boundaries of the water supply watershed, is closed. All solid waste is presently disposed of outside of town boundaries. However, a former town landfill is located in the watershed near the intersection of Main and Middle Street.

Only about 5 percent of the land within the study area is classified as commercial or industrial, as shown in Figures 4-2 and 4-3. The practice of solid waste disposal outside of town boundaries is likely to continue, at least for the short term, so that the possibility of a sanitary landfill being located in the watershed area is remote as is contamination of water supplies by these sources of leachate.

This discussion would not be complete, however, without considering illegal disposal of materials as a source of potential contamination. Regardless of laws against such activities, individuals and industrial concerns have been known to dump wastes into isolated areas using illegal or hazardous methods. Recently, several such instances have been the subject of official action in the town. These include illegal dumping adjacent to the Back River herring run, and filling of Mill River wetlands in the Route 3 Industrial Park with demolition debris. In addition, the partially cleared Libbey Industrial Park site contains trash, yard clippings, old tires, and auto parts. Evidence of dumping can also be found in many areas in which roads and solid waste-generating activities are located adjacent to the rivers. The prevalence of this illegal dumping may be related to the town transfer station being closed on weekends.

Both legal and illegal disposal activities which occur in the water supply watershed, but outside of the town boundaries, may also effect Weymouth's supply sources. For example, filling of wetlands off Grove Street in Braintree has recently been an item of local concern.

d. Existing Regulations and Practices

o Wetlands Protection Act: this act authorizes the Conservation Commission to regulate alteration of wetlands, including filling, by reviewing proposals and issuing Orders of Conditions governing the action.

o Weymouth Article XX, Zoning Bylaw, Earth filling: this article requires a permit from the Building Inspector for filling more than 50 cubic yards if no other town permits and approvals are needed. In other cases, the permit granting board should include the requirements of this article in its review. Granting of the special permit is contingent upon compliance of the proposed action with the Wetlands Protection Act if applicable. Among the conditions of the permit are restrictions on materials which can be used as fill. Restricted materials include garbage, refuse, industrial waste, toxic materials, flammable liquids or gases, highly explosive materials and junk.

e. Recommendations. Monitoring and enforcement of the special permits for filling are necessary to ensure continued protection of water supplies. It will be important to monitor enforcement of the earth filling bylaw since residents may be unaware of it. Because of this, a moderate potential for contamination of water supplies due to leachate exists.

With respect to illegal dumping, in cases where activities are clearly in violation of the law, appropriate sanctions must be imposed. This includes identification of responsible persons, levying fines, and initiation of cleanup activities to correct damage. Publicity on a local level may serve as a deterrent to others.

To aid in reducing illegal dumping, the town should consider reopening the solid waste transfer station on Saturdays or Sundays when its use would be greatest. This could be done on a trial basis to determine the actual need for the weekend opening and to estimate its effect on disposal practices. To offset the cost of the additional hours of operation, weekday hours could be reduced or user fees could be charged.

In addition, increasing general public awareness is important. This should be done by posting signs near public areas identifying the watershed and prohibiting dumping, holding regular community cleanup days, and encouraging neighboring towns to control disposal practices in Weymouth's water supply watershed.

Hazardous Wastes

a. Characteristics and Water Supply Effects. Hazardous wastes are wastes which are toxic, reactive, corrosive or ignitable. Improper handling of hazardous wastes is an ovbious threat to drinking waters; however, federal and state regulations have been enacted to reduce the threat of contamination, including water supply contamination. A less obvious source of hazardous wastes is what is commonly referred to as "household hazaradous wastes". These include materials such as bleach, mothballs, paint remover, oven cleaner, wood preservative, and used motor oil. Improperly disposed of, they also can reach groundwater or surface water and result in contamination of supplies.

Note the distinction between the subject of this section, hazardous "wastes", and the term hazardous "materials". Hazardous materials are more numerous and are not regulated by the state or federal government. Wastes, as discussed here, are the byproducts of manufacturing or other operations, these are subject to the state and federal regulations.

It is significant that the water treatment plants in the town are not capable of removing hazardous wastes (or other hazardous materials) from the water supplies. Therefore any effects on water supplies would be costly and difficult to reverse and could lead to the complete loss of a supply source.

b. Land Use Associations. All land uses except open space and extractive have the potential to be associated with hazardous wastes; hospitals (institutional land use) generate chemical and pathological wastes; transportation corridors are susceptible to accidental spills; and industrial and commercial uses may use, generate, store or dispose of hazardous wastes.

c. Existing Conditions. While most land uses may be associated with hazardous wastes, industrial uses clearly have the greatest relationship with possible use or generation of hazardous substances. Less than one percent of the study area is comprised of industrial uses. There are six hazardous waste generators located in the study area registered with the state and EPA. These are mapped in Figure 4-4. It is not to be assumed, however, that these generators are contaminating water supplies, since their activities are stringently controlled.

Compared to many communities, in metropolitan regions Weymouth has a low percentage of existing industrial development within the water supply watershed. This indicates that the supply sources are generally safe from contamination by either buried hazardous wastes from past operations or by hazardous wastes currently being generated.

d. Existing Regulations and Practices. Hazardous waste generation, storage and transport are regulated by the federal Resource Conservation and Recovery Act (RCRA); the state of Massachusetts has received delegated authority to carry out the program from EPA.

o Massachusetts Hazardous Waste Regulations: provisions of the state regulations include requirements for monitoring groundwater, for secondary containment, leak detection, inspections and a prohibition on locating hazardous waste facilities in the watershed of a surface water supply or on land overlying public water supply aquifers.

o Weymouth Zoning Bylaw, Article XX, Earth Filling: this regulates earth filling as previously described, prohibiting the use of toxic or hazardous substances as fill.

o Weymouth Zoning Bylaw, Article X, Planned Industrial Park District: prohibits the use or storage of hazardous materials in the Planned Industrial Park district, which is adjacent to Whitman's Pond.

o Local Emergency Response Plan; the Fire Department has an assigned Hazardous Materials Officer who is currently documenting procedures for a town Emergency Response Plan. These procedures will include containment, cleanup, notification of state officials, and identification of a responsible party if an emergency occurs. The Mutual Aid District to which the Weymouth Fire Department belongs will provide a specially equipped truck and driver for such emergencies, to be staffed by local Fire Department personnel who are trained in the use of the special equipment.

o There are no regulations governing disposal of household hazardous wastes.

e. Recommendations. The state regulations for hazardous wastes are fairly protective of drinking water resources. However, hazardous wastes are only a small percentage of all hazardous materials. And while the restrictions in the Planned Industrial Park zone protect the property adjacent to Whitman's Pond which is the most critical, it covers only a small portion of the water supply watershed. Therefore, to more thoroughly protect Weymouth's drinking water resources from contamination, careful monitoring of activities which use hazardous materials and dispose of hazardous wastes is advised.

To accomplish the first of these goals, the Board of Health should adopt a hazardous materials regulation to control all use of hazardous materials (including hazaradous wastes). Specific to the needs of Weymouth, it should require local registration of all hazardous materials, development of contingency plans for emergencies, and identification of responsible parties.

With respect to disposal of household hazardous wastes, public education should be provided on proper disposal practices. As both an informational and practical service, the Board of Health and/or the Environmental Protection Committee should hold a household hazardous waste collection day such as those sponsored by the League of Women Voters in about 50 other Massachusetts communities.

Contamination of supplies from accidental spills is significantly reduced because of the emergency response procedures which the town is developing.

Pesticides

a. Characteristics and Water Supply Impacts. The term pesticides includes insecticides, herbicides and rodenticides. These are all chemical compounds used to control unwanted organisms such as insects, weeds and rodents. Since the compounds vary depending upon their target organisms, their potential water resources effects also vary greatly. Pesticides may enter water supplies by direct infiltation through the ground or by way of runoff.

b. Land Use Associations. Land uses associated with use of pesticides are residential, institutional, transportation, utility (electrical), and agricultural. Homeowners use pesticides to control insects, weeds and rodents in gardens and homes. In addition, municipal departments of public works often use herbicides for park or road maintenance.

Utility companies use selective pesticide applications to eliminate tall-growing trees which interfere with the function of the utility lines. The general amount of herbicide used for this is less than one gallon per acre.

The intent of railroad herbicide applications is to control all vegetation along the track since it may cause instability or lead to fires. The area usually treated is about 12 feet to either side of the center of the track, known as the railroad layout or ballast area. A number of chemicals are used together which generally amount to 5 to 8 gallons of herbicide per acre.

Organic pesticides may be used directly in water supply reservoirs for control of aquatic plants or aquatic insects. Other methods of their reaching water bodies are the accidental or deliberate discharge of wastewater from manufacturing the pesticides, accidental drift from agricultural applications, and discharge of rinse water from equipment cleanup after application.

c. Existing Conditions. Land uses that exist in Weymouth which are typically associated with use of pesticides include residential, institutional and transportation/utilities. There is virtually no agricultural land left in the town. As shown in Figures 4-2 and 4-3, approximately 45 percent of the watershed area is comprised of the critical uses. Pesticides are not used to control weeds in Whitman's Pond.

At least three rights-of-way which require herbicide applications pass through the watershed area of Weymouth (see Figure 4-4). The Massachusetts Electric Company and the Boston Edison Company have easements, and the Massachusetts Bay Transportation Authority owns a railroad line that runs across the southwest corner of the town between Braintree and Abington. In all, about 50 acres of watershed land receive herbicide applications, 7 acres for railroad maintenance and 42 acres for the electric utility rights-of-way. Professional arborists oversee these activities.

In Weymouth, neither the School Department nor the Park Department uses herbicides to control weeds in town parks or playing fields, nor has aerial spraying been done by the town for insect control for at least 10 years. Occasionally, upon request from a private landowner, the Park Department uses controlled spraying from trucks to kill poison ivy on public land.

Although it is unlikely that additional electrical or railroad easements will be constructed within the water supply watershed, overall, future pesticide use is likely to be fairly widespread due to the extent of residential land uses. Domestic use of pesticides may therefore be the primary threat to drinking waters in Weymouth.

d. Existing Regulations and Practices.

o State Guidelines for Right-of-Way Maintenance: application of herbicides to rights-of-way is carried out under the jurisdiction of the Pesticide Bureau of the Massachusetts Department of Food and Agriculture. The bureau is currently involved in a program to provide a set of final regulations, based on scientific data that would protect public and private drinking water sources from potential contamination by herbicides.

Two sets of Interim Guidelines have been issued governing herbicide application. One regulates herbicide use on ballast areas of railroad layouts, and the other addresses herbicide use for control of woody vegetation on both railroad layouts and in utility rights-of-way. Both sets of guidelines restrict applications of pesticides to within 400 feet of a gravel-packed well or surface water supply, including tributary streams. Krenite is to be used between 400 feet and 50 feet of a water supply source for control of woody vegetation in railroad layouts and utility easements. A 100 foot buffer is to be left on either side of a railroad ballast where it crosses a stream tributary to a surface water supply.

o Board of Health Regulation No. 14: this regulation requires a special permit from the Board of Health for all non-domestic uses of pesticides which the manufacturer restricts use of in the vicinity of public or private water supplies. The EPA requires that labels contain such warnings for pesticides which contain chemicals with long break-down periods. Applications for special permits must include an Emergency Spill Response Plan and must be filed annually. The Board has authority to impose restrictions to applicants such as a maximum wind velocity for any aerial spraying. Criteria used by the Board of Health to evaluate Special Permit applications include the appropiateness of the pesticide for its intended use and the method of application.

e. Recommendations. The state believes that pesticides used in accordance with directions are unlikely to migrate into drinking water supplies. Therefore, the Board of Health regulation should continue to be enforced. The Board should use its knowledge of the location and characteristics of the water supply watershed in doing this. It should also take advantage of the information on the movement of pesticides through the environment which will be available from the Department of Food and Agriculture in the near future. In reviewing special permit applications, some of the specific water supply buffer requirements recommended by the state should be considered. The Board may should identify these buffer areas in the regulation.

Overall, the water supplies are largely protected from pesticide contamination by non-domestic users by the state and local regulations. Therefore due to the prevalence of residential development, particularly in close proximity to Whitman's Pond, public education on the possible effects of misusing pesticides around the house will be important. The Board of Health may make information packets available or pamphlets could be distributed through the school system. The state Pesticide Bureau operates a county extension service which distributes information to the public and may be able to provide advice.

Fertilizers

a. Characteristics and Water Supply Impacts. Fertilizers contain nutrients which are applied to vegetation to induce growth. When the large concentrations of phosphorus and nitrogen in fertilizers are not taken up by the plants, they can wash off into surface water bodies.

High levels of nutrients in ponds and streams (which also result from improperly operating septic systems) stimulate the growth of algae which depletes the supply of dissolved oxygen. This has adverse effects on biological organisms; however, the primary effect of high levels of nutrients on drinking water supplies is to increase the cost of water treatment. Also, in certain circumstances, high nitrate concentrations can be toxic to infants, but these waters would be severely polluted and bacterially unacceptable for drinking.

b. Land Use Associations. Land uses associated with use of fertilizers are residential and institutional.

c. Existing Conditions. Approximately 45 percent of the study area is comprised of residential and institutional uses. In Weymouth, the Park Department and the School Department use fertilizers to maintain the public parks and ball fields. In addition, homeowners use them widely in their yards to enhance their landscaping. Whitman's Pond water has been determined to have high levels of nutrients due to the urbanized nature of its storm drainage basin; there are more than 30 storm drain outlets which enter the pond. Stormwater also discharges directly to the Old Swamp River.

d. Existing Regulations and Practices. There are no regulations which govern the use of fertilizers.

e. Recommendations. Since approximately 65 percent of the undeveloped land in the study area is zoned to allow residential and institutional land uses, it is likely that widespread use of fertilizers will continue in the future. Although reduction of nutrients is not critical to protection of drinking water, water treatment costs could be controlled by reduced fertilizer usage within the water supply watershed area.

Nutrient control is one of the goals of the long-range lake restoration plan for Whitman's Pond and water supply issues should be included in the program. The plan includes structural measures, such as aeration and construction of a nutrient uptake pond, as well as a public education element to inform homeowners of the effects of fertilizer use on the pond. In addition, the town Parks Department and School Department should be encouraged to use only the amount of fertilizer necessary for grounds maintenance within the water supply watershed.

Surface Waste Impoundments

a. Characteristics and Water Supply Impacts. Surface (as opposed to underground) waste impoundments are ponds, basins, excavations or pits used to store, process or dispose of some form of liquid or semi-liquid waste material. Some are designed specifically to leach their contents into the ground or a nearby waterbody. These are likely to be unlined and are typically located over porous sand and gravel soils. They may easily cause groundwater contamination by direct infiltration of their contents into soils.

b. Land Use Associations. Open tanks or lagoons are often used to store, treat and dispose of domestic sanitary wastes. Industries may use stabilization ponds for waste treatment, and agricultural impoundments are often used for storage, treatment and disposal of animal wastes. The land uses which may be associated with surface waste impoundments are therefore industrial, disposal and agricultural.

c. Existing Conditions. Less than one percent of the area comprising the supply watershed is developed for industrial land uses. There are no known surface waste impoundments for animal wastes in the town, and no disposal land uses are located in the study area.

Two surface waste impoundments in the study area were identified by the state DEQE in a 1980 survey. Figure 4-4 shows the one located in Weymouth which is actually two unlined ponds, possibly used for collection of stormwater runoff (its Standard Industrial Classification code is for collection, treatmemnt or disposal of sewage). In addition, five impoundments were located in Hingham at Merriman Division of Litton Industries in the South Shore Industrial Park. Merriman holds an NPDES permit for these lagoons which are used to dispose of wastes from the plant (see wastewater section also). According to DEQE, the lagoons contain no hazardous wastes or other potentially harmful contaminants which could be a threat to groundwater supplies.

d. Existing Regulations and Practices.

o The Massachusetts Wetlands Protection Act: this grants local Conservation Commissions the authority to regulate construction in wetland areas including installation of surface waste impoundments, which can be prohibited to protect wetland values.

o National Pollutant Discharge Elimination System: some of the older surface waste impoundments operate within effluent guidelines established in NPDES permits. This program was established to control direct discharges to water bodies.

o Groundwater Discharge Permits: chapter 21, section 43 of the Massachusetts Clean Waters Act requires any discharge of pollutants to groundwaters of the Commonwealth to receive permits from the Division of Water Pollution Control unless exempted by the implementing regulations, 314 CMR 5.00. The regulations require permits to discharge to groundwater from a number of sources including surface waste impoundments. Merriman Division of Litton Industries has applied for this permit.

o Massachusetts Hazardous Waste Regulations: any surface impoundment which is to contain hazardous wastes is under the jurisdiction of the Massachusetts Hazardous Waste Regulations (310 CMR 30.000) which establish technical standards for new facilities that treat, store, use, recycle or dispose of hazardous wastes. The specific requirements which protect drinking water supply sources are described in the previous section on Hazardous Wastes.

e. Recommendations. In general, the threat of future contamination from surface waste impoundments is small. This is because about 11 percent of the land available for development in the study area zoned I-1, which is the district most likely to be associated with the use of waste impoundments. It is significant that hazardous waste impoundments are prohibited in watershed areas. However, the groundwater discharge permit program is perhaps more important to Weymouth because it mandates that all discharges to groundwaters obtain state permits. This provision may be needed in the future to protect Weymouth's supplies, particularly since the town is pursuing industrial development which could generate wastes other than the hazardous wastes which are prohibited.

The town should add a local control mechanism to the state review process which would regulate surface waste impoundments due to the newness of the state programs and to the town's more thorough knowledge of environmentally sensitive areas. This should be done by designating surface waste impoundments for potentially harmful substances a prohibited use within the proposed new overlay zoning district for watershed protection.

Abandoned Wells and Septic Systems

a. Characteristics and Water Supply Impacts: Private wells which have been abandoned and not completely closed by backfilling are potential sources of contamination to groundwater because of their direct connection to aquifers. People may use abandoned wells for disposal of small amounts of wastes such as used motor oil; abandoned wells may also be used for illegal dumping. In addition, contaminants contained in stormwater runoff and contaminants from accidental spills can flow into improperly closed wells. Abandoned cesspools and septic tanks (on-lot wastewater disposal systems) may be used similarly for disposal. Contamination could result from infiltration through soils to water supplies.

b. Land Use Associations. The presence of abandoned wells and on-lot wastewater disposal systems is associated with residential, commercial and industrial land uses which have tied into a public water main or sewer.

c. Existing Conditions. It is uncertain now many abandoned wells and on-lot wastewater disposal systems are located in Weymouth. The water Division of the Department of Public Works has knowledge of approximately 80 private wells that are not being pumped. However, it is likely that there are many more, particularly in the older sections of town, because most of the town is currently served by the public water system. These are most likely to be in residential areas, although commercial and industrial sites which were developed before expansion of the water system may also have unused, uncapped wells on the property. Approximately 50 percent of the study area is comprised of these land uses.

In addition, the Water Division estimates that there may be approximately 200 private wells still being used throughout the town, primarily for purposes other than drinking water supply. At some time in the future they may be abandoned, and their presence indicates a moderate potential for groundwater contamination related to improper closure. Likewise, as residents tie into sewers, their existing disposal systems will be abandoned. Approximately 30 percent of the town's wastewater generators are not tied into available sewers.

d. Existing Regulations and Practices. Proper closure of wells and on-lot wastewater disposal systems by backfilling is not required by any local or state laws or regulations.

e. Recommendations. Given the likelihood that these abandoned facilities are prevalent throughout the town, the Water Division and the Sewer Division of the town Department of Public Works should institute programs which require proper closure of wells and on-lot sewage disposal systems. The item could be included in the applicataions for tie-ins. In addition, public information should be provided on the potential water supply impacts associated with abandoned wells and on-lot systems; and property owners should be encouraged to properly close any existing or future abandoned facilities.

Other Sources of Contamination

Environmental literature addresses a number of other potential contamination sources which are not significant problems in Weymouth and have not been evaluated here. These sources include land application of liquid wastes, acid rain, underground injection wells, saltwater intrusion, mining, and municipal and industrial sludge disposal.

SUMMARY

This chapter has focused on the effects that developed land uses may have on water supplies. For reference, Table 4-4 summarizes the characteristics of the drinking water contaminants analyzed in this study and Figure 4-5 shows the land uses which have been described as typically associated with the individual sources of contamination. Chapter 6 provides a summary of the land use/water supply incompatibilities discussed here and sets forth a watershed protection plan designed to address all of these issues.

TABLE 4-4 CHARACTERISTICS OF DRINKING WATER CONTAMINANTS

CONTAMINANT	LAND USE ASSOCIATIONS	INCOMPATABILITY WITH DRINKING WATER RESOURCES
Runoff and erosion	All developed	- Dissolves and carries street grime, oil and grease, salt, fertilizers, etc. to surface waters - Increases storm runoff to surface waters - Increases turbidity in surface waters - Decreases natural percolation and groundwater recharge
Abandoned wells	Residential Commercial Institutional Industrial	- May be used for waste disposal - Can collect surface contaminants - Drilled directly into aquifers
Waste-water	Residential Commercial Industrial	- Failing on-lot systems introduce excessive nutrients, bacteria, chlorides and household chemicals into groundwater and surface water - Sanitary sewer overflows, including some industrial wastes, and storm sewer overflows have same impact - Septic systems on lots less than 40,000 square feet may contaminate groundwater - Leaks in sanitary sewers can contaminate groundwater - Direct discharge from treatment plant to surface water bodies can degrade quality
Road deicing chemicals	All except Extractive and Disposal	- Washes off pavements to surface water bodies where it increases sodium levels - Percolates through soils to groundwater - Conventional water treatment has no effect on removal of sodium chloride
Leachate	Commercial Industrial Disposal	- Dissolved contaminants from landfill can percolate to groundwater - May also contaminate surface water - Conventional water treatment may not remove chemical contaminants
Surface waste impoundments	Industrial Disposal	- May be unlined and allow direct infiltration to groundwater - Conventional water treatment may not remove chemical contaminants
Underground storage of fuels and chemicals	Residential Institutional Commercial Industrial	- Leaks due to corrosion, aging or improper installation can contaminate groundwater - May also contaminate surface water - Punctures from frequent testing can also cause leaks - Conventional water treatment may not remove chemical contaminants
Pesticides (insecticides and herbicides)	Residential Institutional Transportation/ Utility r.o.w. maintenance	- May be applied directly to surface water body for insect or plant control - Used by both professionals and non-professionals - Washes into surface water bodies by runoff - Percolates through soils to groundwater - Rinse water from equipment cleanup requires proper disposal - Containers require proper disposal - May drift accidentally from controlled applications - Conventional water treatment may not remove chemical contaminants
Fertilizers	Residential Institutional	- Washes into surface water bodies by runoff - Increases nutrients in the form of phosphates and nitrates - Nutrient removal increases water treatment costs due to algal growth - High nitrite concentrations may be toxic to infants under some conditions
Hazardous wastes	All except Extractive	- Improper storage, transport or disposal threatens surface waters and groundwaters - Contaminants are not removed by water treatment

FIGURE 4-5 EFFECTS OF LAND USES ON WATER SUPPLY SOURCES

LAND USE	PERCENT OF WATER-SHED AREA	POTENTIAL DRINKING WATER CONTAMINANT									
		Runoff & Erosion	Abandoned Wells	Wastewater	Road Salts	Leachate	Surface Waste Impoundments	Underground Fuel Storage Tanks	Pesticides	Fertilizers	Hazardous Wastes
Residential-single family	39	○	○	●	○			○	○	○	○
Residential-multifamily	3	●		○	○			○	○	●	○
Institutional	3	●		○	●			●	○	●	○
Commercial	4	●	○	○	●	○		○			○
Industrial	< 1	●	○	○	●	○	○	●			●
Transportation/Utilities	1	●			●				●		○
Extractive	< 1	●									

● Probable relationship
○ Possible relationship

CHAPTER 5

ZONING - REGULATION OF FUTURE LAND USE

This analysis focuses on zoning and land development. The zoning analysis is part of the watershed protection study because an examination of the potential future developments which may affect water supplies is necessary.

Zoning determines the type and extent of modifications that can occur to existing buildings.* However, zoning's primary function is to regulate new construction in the areas of town that are still undeveloped. Therefore, this analysis centers on zoning of the undeveloped property in the water supply watershed because these are the areas on which zoning will have the greatest effect.

In Weymouth, approximately 28 percent (1,550 acres) of the study area is still undeveloped. This includes only property which is privately owned and available for development. The delineation is taken from the map of existing land uses. Figure 5-1 shows the existing zoning districts for all of the property within the water supply watershed, and Figure 5-2 illustrates the same zoning districts but only for the land which is presently undeveloped. Table 5-1 summarizes the approximate percentages of land zoned for each type of development.

TABLE 5-1. ZONING IN THE WATER SUPPLY WATERSHED

DISTRICT	PERCENT OF UNDEVELOPED LAND	PERCENT OF ENTIRE
R-1 Residential	64	73
R-3 Residential	1	1
R-4 Residential	5	3
B-1 Business	13	7
B-2 Business	1	1
I-1 Industrial	9	3
PIP Industrial	7	2
I-2 Industrial	0	1
POS Public Open Space	1	9

*The town Board of Zoning Appeals has authority to grant "dimensional" variances from the requirements of the Zoning Bylaw under certain conditions. However, no "use" variances may be granted in the town.

F

Figure 5-1

ZONING

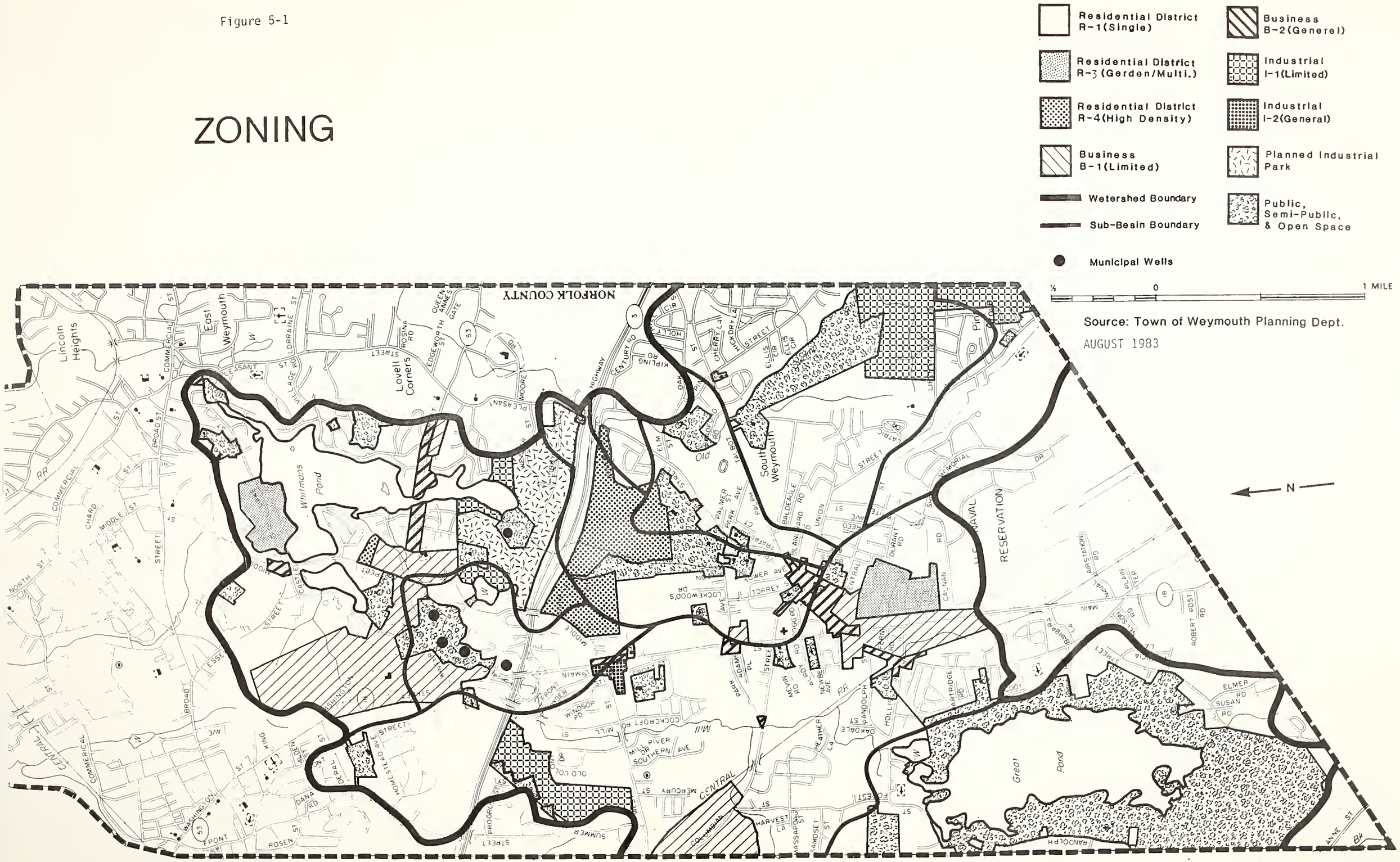
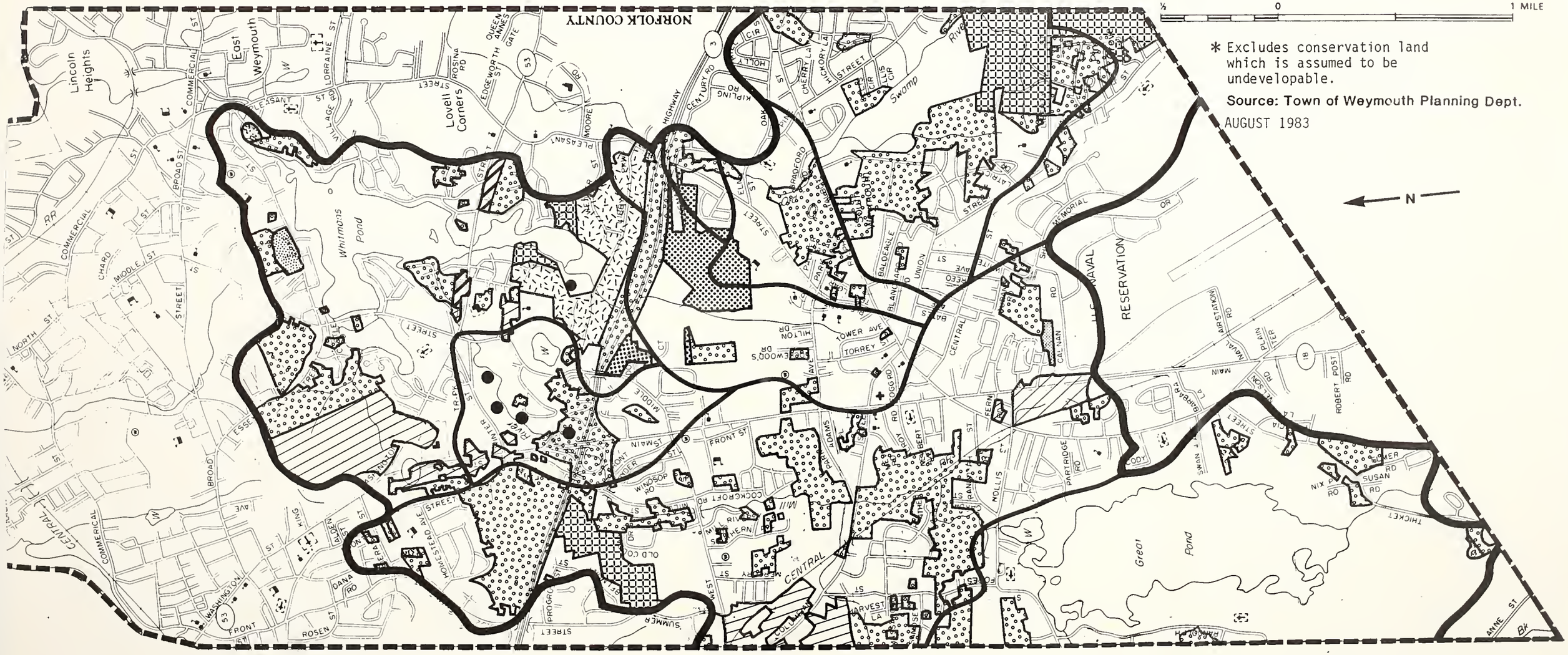


Figure 5-2

UNDEVELOPED LAND BY ZONING DISTRICT*



* Excludes conservation land which is assumed to be undevelopable.

Source: Town of Weymouth Planning Dept.

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Zoning controls set forth in the bylaw applicable to water resources protection are described in the remainder of this chapter. This includes descriptions of the land uses allowed by the bylaw in each zoning district and consideration of the compatibility of each use with the goal of watershed protection. Commercial uses such as printers and dry cleaners are connected to sewers and are therefore not treated as a threat to Weymouth's water supplies. Two other criteria used to identify incompatible uses are density of development and maximum lot coverage. In all cases, uses which are allowed by right, by Special Permit of the Board of Zoning Appeals, and with site plan review by the Planning Board are treated as though they can be developed with only limited consideration of water supply effects. This is because the Board of Zoning Appeals has no known formal mechanism for considering environmental issues, and the Planning Board's site plan review procedures are advisory only. Figure 5-3 summarizes the land uses allowed in the districts and the potential water supply contaminants associated with each.

RESIDENTIAL ZONE: R-1 DISTRICT

a. Description. The R-1 district is a single family residential zone in which municipal uses are also allowed and, under some circumstances, other generally non-intensive uses such as funeral homes, greenhouses, and automobile storage garages can be constructed. The minimum lot area per residence is 15,000 square feet, for an average density of about 3 units per acre. The maximum lot coverage is 30 percent of the property, not including driveways and other paved areas.

Most of the undeveloped land within the watershed (approximately 65 percent) is zoned R-1, and about 75 percent of the entire watershed is zoned for single family residences. Several large parcels adjacent to both Old Swamp River and Mill River are included, and much of the area contains wetlands.

The primary threats to watershed protection of the R-1 property are prevention of natural recharge due to land coverage with impermeable surfaces, and activities such as use of road salts, pesticides and fertilizers which can introduce contaminants to drinking waters. For garages, storage and disposal of gasoline and oils may result in a water quality problem. Underground storage tanks and disposal of wastewater and household hazardous wastes may be associated with single family residential developments and can affect water supplies.

b. Recommendations. Because of the amount of undeveloped land zoned R-1, and because it is largely environmentally sensitive, it is vital to monitor future development as well as redevelopment and expansion of existing residential uses. The zoning bylaw should be amended to protect water supply recharge areas by creating an overlay district specifically for the purpose of watershed protection (see Chapter 6). The district should require larger lots as a minimum size for construction of single family homes. There is also a need for the town to adopt an underground fuel storage bylaw which will give additional authority to the Fire Department to continue monitoring applications for installation of

FIGURE 5-3 ZONING/LAND USE RELATIONSHIP AND POTENTIAL WATER SUPPLY EFFECTS

ZONING DISTRICT	ALLOWED LAND USES	POTENTIAL DRINKING WATER CONTAMINANTS*									
		Runoff & Erosion	Abandoned Wells	Wastewater	Road Salt	Leachate	Surface Waste Impoundments	Underground Fuel Storage	Pesticides	Fertilizers	Hazardous Wastes
R-1	Single family residential	○	○	●	○			○	○	○	○
	Commercial (S.P.)**	●	○	○	●	○		○			○
	Transportation/Utilities	●			●				●		○
R-3	Single family residential	○	○	●	○			○	○	○	○
	Multifamily residential	●		○	○			○	○	●	○
	Commercial	●	○	○	●	○		○			○
	Transporation/Utilities	●			●				●		○
R-4	Multifamily residential	●		○	○			○	○	●	○
	Commercial	●	○	○	●	○		○			○
	Transportation/Utilities	●			●				●		○
B-1	Single family residential	○	○	●	○			○	○		○
	Commercial	●	○	○	●	○		○			○
	Transportation/Utilities	●			●				●		○
B-2	Multifamily residential	●		○	○			○	○	●	○
	Commercial	●	○	○	●	○		○			○
	Transportation/Utilities	●			●				●		○
I-1	Commercial	●	○	○	●	○		○			○
	Industrial	●	○	○	●	○	○	●			●
	Transportation/Utilities	●			●				●		○
PIP	Industrial	●	○	○	●	○	○	●			●
	Transportation/Utilities	●			●				●		○
I-2	Industrial	●	○	○	●	○	○	●			●
	Transportation/Utilities	●			●				●		○
POS	Open Space								○	○	
	Single family residential(S.P.)	○	○	●	○			○	○	○	○
	Multifamily residential (S.P.)	●		○	○			○	○	●	○
	Institutional	●		○	●			●	○	●	○
	Commercial (S.P.)	●	○	○	●	○		○			○
	Transportation/Utilities	●			●				●		○
	Extractive	●									

* All data on drinking water contaminants is from previous Figure 3-3.

**S.P. = Allowed with Special Permit by the Planning Board

● = Probable relationship

○ = Possible relationship

RESIDENTIAL ZONE: R-3 DISTRICT

a. Description. The R-3 zone is also for residential development, but, in addition to single family homes, it allows for denser residential and other uses in the form of garden apartments, nursing homes, nursery schools, hotels, and apartment accessory uses such as hairdressers and barber shops. The required minimum lot size for one and two family residence buildings is 15,000 square feet. For higher density residential uses, the average density is based on a floor area ratio of 0.25, or a total floor area not greater than 25 percent of the area of the parcel of land. More important to this study, up to 85 percent of a parcel of property may be rendered impervious, either by construction of a building or by paving. In fact, the whole parcel could be paved in accordance with the bylaw because the actual requirement is for a minimum of 15 percent landscaped area and it would be possible to "landscape", for example, with bricks and planters.

Less than one percent of the undeveloped land in the study area is zoned R-3 and only about 1 percent of all of the land in the water supply watershed is zoned for these uses. The critical land uses for watershed protection and the associated potential contaminants described for the R-1 zone apply to this zone also. However, the association with use of underground fuel tanks and road salts for deicing driveways and parking lots may be greater for the higher density residential units found in R-3 districts.

b. Recommendations. Due to the limited amount of land zoned R-3, the concerns for this district can be addressed appropriately through creation of a watershed protection zoning district, additional monitoring of underground fuel storage tanks, and continued monitoring of road salt use in private developments.

RESIDENTIAL ZONE: R-4 DISTRICT

a. Description. Property zoned R-4 can contain the most dense residential development in the town. In addition to multiple unit dwellings, the district provides for Planned Unit Developments with associated commercial and office uses, and also hotels, marinas, yacht clubs and boat sales. Density requirements for one and two family residences are the same as the R-3 zone, and the floor area ratio for more than two family residences is 0.30. Again, the bylaw calls for landscaping a minimum of 15 percent of the parcel which means that most of a parcel could be rendered impervious, preventing natural recharge.

About 5 percent of the undeveloped land in the study area and 3 percent of the entire watershed is zoned R-4. This acreage is comprised primarily of the Tall Oaks property adjacent to the Old Swamp River for which a phased condominium project will be constructed under zoning provisions of a previous bylaw.

b. Recommendations. As it is unlikely that any of the remaining existing R-4 property will be developed for any but residential use, the primary concern for watershed protection is lot coverage. If property is rezoned to R-4 in the future, potential contaminants such as underground storage tanks, wastewater, road salts, pesticides and fertilizers may become of greater concern. Under the present circumstances, however, only enforcement of the existing Board of Health road salt regulation and adoption of an underground fuel storage bylaw should be necessary.

BUSINESS ZONE: B-1 DISTRICT

a. Description. B-1 zones are limited business zones in which single family dwellings and also light commercial uses such as printers, service stations, car washes, and small shopping centers can be constructed. Up to 50 percent of a lot may be covered by a building, and a minimum of 10,000 square feet is required for any single use.

About 13 percent of the undeveloped land in the study area and 7 percent of all of the land in the watershed is zoned for B-1 uses. Included in this acreage is about 85 acres of land along Washington Street in the Whitman's Pond drainage subbasin. Although not abutting the pond, the land drains to its west cove and is therefore sensitive.

The allowable lot coverage is fairly high and could have adverse effects on the ability of the drainage basin to recharge the pond. The district's allowable uses of concern to watershed protection are the car washes, which discharge large quantities of soaps and detergents, and service stations, which require underground fuel storage. It is assumed that the small amounts of chemical wastes generated at printers would be discharged to a sewer. Other potential contaminants associated with the B-1 district land uses are wastewater discharges and road salt and pesticide application.

b. Recommendations. Neither the car washes nor the service stations should be prohibited from the B-1 zones in the watershed area. Rather, the car washes can be controlled through the special permit process of the Board of Selectmen. The Board should be given written criteria for approval of permits for proposed facilities to be located inside the boundaries of the supply watershed. These criteria would include review of site drainage and assurance that all runoff from the operation would be discharged to a sanitary sewer with adequate capacity to handle the increased flow. With respect to the service stations, implementation of the recommended underground fuel storage bylaw would provide the necessary protection for the supply sources against contamination from fuels.

BUSINESS ZONE: B-2 DISTRICT

a. Description. The B-2 zone is the general business zone in which more intensive business uses can be constructed. No single family residences are allowed in the district. However, multiple unit dwellings can be built. In addition to the commercial uses allowed in the B-1 zone, auto and motorcycle rentals and auto and truck sales may be operated. There is no minimum lot size or maximum lot coverage requirement in B-2 zones.

Only about 10 acres of undeveloped property in the study area are zoned B-2. This is a relatively small amount of land, however, it may be significant because it is located along Washington Street, in close proximity to Whitman's Pond. The potential for contamination by all of the sources identified under the B-1 zone exists also for this parcel. In addition, the vulnerability of the pond to contamination by leaking underground fuel tanks is greater because of the automotive uses allowed. Problems related to runoff and depleted recharge ability also apply.

b. Recommendations. The B-2 property should be re-zoned to B-1, which would eliminate the more intensive automotive uses and adequately address all of the concerns.

INDUSTRIAL ZONE: I-1 DISTRICT

a. Description. I-1 is the industrial park zone which provides a location for activities such as auto and truck sales, motor freight and bus terminals and yards, and manufacturing and assembly plants including storage of flammable materials. No residential development is allowed in I-1 zones. The minimum lot size is 20,000 square feet, and up to 80 percent of the lot may be covered by a building.

Approximately 9 percent of the undeveloped land in the study area (3 percent of all of the watershed land) is zoned I-1. Included in the watershed acreage is an approximately 100 acre parcel in South Weymouth which drains to the Old Swamp River near the town gravel screening plant and 12 acres adjacent to the south cove of Whitman's Pond.

In general, the intensive uses allowed by the district conflict with the objectives of watershed protection. This is significant because of the large undeveloped area zoned I-1. Besides the high percentage of lot area which can be covered, diminishing the recharge capacity of the water supplies, critical activities associated with I-1 land uses include underground storage of fuels and chemicals, disposal of liquid wastes from manufacturing processes, and the increased likelihood of industries locating in these sensitive areas which might use hazardous substances. Other potential contaminants which may be associated with the industrial activities in these districts include road salts, leachates, pesticides and surface waste impoundments.

b. Recommendations. A number of actions should be taken to reduce the threat of contamination of water supplies associated with activities allowed in I-1 districts. The areas currently zoned I-1 should be re-zoned to Planned Industrial Park which sets performance standards for industries. In addition, the more incompatible industrial-related activities should be prohibited by creation of a Watershed Protection District. These actions, coupled with a Board of Health hazardous materials regulation and an underground fuel storage bylaw, would contribute significantly to protection of the water supply sources of the town.

INDUSTRIAL ZONE: PLANNED INDUSTRIAL PARK (PIP) DISTRICT

a. Description. This zone was established to set site plan design standards and environmental and other performance standards for industrial uses located in the Libbey Industrial Park which is adjacent to Whitman's Pond and Whitman's Pond well. Manufacturing and assembly concerns can be constructed in the PIP district, as can printers, motor freight and bus terminals and yards. Storage, use and manufacturing of hazardous materials are allowable in the district. Regulatory standards governing the development of the latter three categories of uses include consideration of impacts on municipal water supplies. These include requirements for oil separation devices in catchbasins, roof drains which discharge to the ground, connection of all waste discharges to existing sewers, and a special permit for manufacturing or storage of chemicals and for storage of napthas (solvents). In addition, salt applications to paved surfaces are prohibited. Buildings may be constructed on lots no less than 1 acre (43,560 square feet) in size, and 40 percent of each parcel in the PIP district must remain in a natural state.

About 7 percent of the undeveloped land in the study area is zoned for PIP development. The district was created rather recently for the purpose of protecting Whitman's Pond from contamination by restricting potential drinking water contaminants such as wastewater, road salts and hazardous materials. However, the requirements may not be protective enough for other contaminant sources such as leachates, surface waste impoundments and underground storage tanks.

b. Recommendations. More stringent regulation is needed for all underground storage of fuels and all manufacturing, storage and use of hazardous chemicals in the zone because the area currently zoned PIP is both extensive and environmentally sensitive. Such regulation can be accomplished through the zoning overlay district for watershed protection, by adoption of an underground fuel storage bylaw, and by the Board of Health adopting a hazardous materials regulation.

INDUSTRIAL ZONE: I-2 DISTRICT

a. Description. The I-2 district is the general industrial zone in which the most intensive development in the community can occur. There is no undeveloped land zoned I-2 in the watershed area and less than 1 percent of all of the land in the study area is in this classification. In addition to the I-1 land uses, dry cleaning establishments, water freight terminal facilities, marinas and boat sales, printers, and open lot storage of coal, coke and solid fuel are allowed in I-2 zones. The potential contaminants associated with I-2 land uses are the same as those identified for the I-1 zone.

b. Recommendations. If property within the watershed area is ever zoned to I-2, it will be critical for the town to have established other protection mechanisms regulating discharge of wastes and storage of potentially harmful substances.

PUBLIC OPEN SPACE (POS) DISTRICT

a. Description. Municipal uses and cemetaries may be located by right in POS districts. "Municipal uses" includes both non-intensive uses such as parks and playgrounds, and more intensive uses such as schools and public works facilities. A special permit provision exists to regulate reuse of public property which has been declared surplus: with a special permit, single and multi-family residential developments or commercial and business establishments may be constructed for reuse of surplus public property. To date, these have been primarily school reuse projects.

Less than 1 percent of the undeveloped property in the study area is zoned POS. However, because of the provision for reusing surplus municipal property for commercial and business activities, it is more significant that 9 percent of all of the land in the watershed is zoned POS.

b. Recommendations. Although the Planning Board requires an environmental assessment as part of its special permit review, the diversity of uses allowed with the permit, coupled with the extent of land zoned POS, indicates that additional protection of the watershed from contaminants such as road salts and underground fuel tanks is warranted. These concerns should be addressed through adoption of the zoning and underground fuel storage bylaws.

FLOODPLAIN DISTRICT

a. Description. The Floodplain district is an overlay district which encompasses all of the area determined by the Federal Department of Housing and Urban Development to be prone to flooding in severe storms. In general, all of the land adjacent to the river banks and ponds is subject to flooding. The overlay district requires a special permit from the Planning Board for all construction in the 100 year floodplain. In addition, it requires that the lowest floor elevation of a building be 1 foot above the elevation of the 100 year flood, which generally encourages filling and construction in environmentally sensitive areas. Such construction can reduce the flood storage capacity of the waterbody.

b. Recommendations. These incompatibilities should be remedied by prohibiting all construction within 25 feet of the surface water bodies. This provision is recommended for inclusion in the proposed watershed protection zoning overlay district.

SUMMARY

This evaluation has identified specific parcels of property within the town's water supply watershed on which land use incompabilities are likely to be introduced if the land is developed in accordance with the existing zoning bylaw. Incompatible land uses include business and industrial activities that generate waste substances, and relatively dense single family residential development in sensitive areas adjacent to ponds and streams. As outlined in the next chapter, recommended actions include both rezoning and efforts to manage construction and operation as part of site plan review and special permit requirements.

CHAPTER 6

SUMMARY AND RECOMMENDED PROTECTION PLAN

This chapter summarizes the analysis of land uses and zoning which were presented in detail in Chapters 4 and 5. The information gathered in the detailed analysis has been used to develop the Watershed Protection Plan which is outlined in the final section of this chapter.

Figure 6-1 summarizes the town policies that Weymouth currently has in place which contribute to protection of its water supplies. Additional measures are necessary, however, to ensure continued protection of adequate supplies. In general, this is because the town's applicable regulations were not designed specifically for watershed protection and because some potential contaminants are not regulated at all.

LAND USE CONFLICTS

Table 6-1 summarizes the potential threats to Weymouth's water supplies which were identified in Chapter 4. Land use incompatibilities are summarized for each potential contaminant that has been addressed. The table also lists the measures recommended to reduce each potential threat described.

The most significant point sources of potential contamination are the underground fuel storage tanks and illegal disposal sites which can generate leachates. The first challenge represents a direct threat, as the existing steel tanks may begin leaking at any time in the future. The second challenge is less tangible because the municipal landfill, which is closed, is located outside of the water supply watershed. However, water supply threats from leachates are still significant because individuals and industrial concerns have been known to dump solid and liquid wastes into isolated areas in town using illegal or hazardous methods. Several instances have been the subject of official action in the recent past, and it will be necessary to attempt to prevent damage to water resources from this source of possibly serious contamination.

It is important to recognize that the threat from both of these major land use incompatibilities extends beyond the borders of the town of Weymouth. For this reason, efforts toward a program of intermunicipal cooperation, as outlined in the recommended plan, will be central to protecting the water supply watershed.

ZONING CONFLICTS

Table 6-2 summarizes the land uses allowed by the zoning bylaw which have been identified as incompatible with the goals of watershed protection. The most significant zoning issues are the property zoned I-1 along the Old Swamp River and the B-1 and B-2 property in the vicinity of Whitman's Pond. Although development of much of the I-1 property will be regulated by the Conservation Commission because of the extensive wetlands in the area, stricter controls should be imposed because of the sensitivity and extent of the land. Land use incompatibilities associated with the business districts are less severe because the area involved is smaller and because there are fewer and less noxious potential contaminants involved.

FIGURE 6-1 LOCAL LAND USE MANAGEMENT TECHNIQUES

POTENTIAL CONTAMINANT	LOCAL REGULATION																
	Planning Board/Zoning Board of Appeals							Board of Health									
	Zoning Bylaw	o earth removal	o earth filling	Special Permit/ Site Plan Review	Subdivision Regulations	Road Salt Regulation	Pesticide Regulation	Hazardous Materials Regulation	Building Inspection Codes	Sewer Division Regulations	Highway Division Practices	Water Division Regulations	Fire Dept. Codes and Practices	Conservation Commission Orders of Conditions	Special Protective Bylaw	Intermunicipal Cooperation	Whitman's Pond Restoration Plan
Runoff & Erosion	●	●	●	●	●				●					●		○	
Abandoned Wells										○		○					○
Wastewater	●			●	●				●	●						○	○
Road Salts	●					●					●			●			
Leachate	●		●						●					●		○	○
Surface Waste Impoundments	○													●			
Underground Fuel Storage	●							○					●	●	○		
Pesticides							●										○
Fertilizers																	○
Hazardous Wastes	●		●					○						●			○

● Existing Protection Mechanism

○ Possible Protection Mechanism

TABLE 6-1 SUMMARY OF LAND USE INCOMPATIBILITIES WITH WATERSHED PROTECTION

Potential Contaminant	Threats to Drinking Water	Recommendations
Runoff and Erosion	- Dense development around Whitman's Pond, in some areas adjacent to rivers, and in neighboring towns. - Large tracts of land still available for development, in Weymouth and in neighboring towns.	- Planning & Zoning Appeals Boards and Conservation Commission continue enforcement of zoning, subdivision and wetlands protection regulations. - Standardize criteria for acceptance of runoff and erosion control plans. - Increase performance standards for earth removal. - Initiate intermunicipal contacts.
Abandoned Wells and Onlot Wastewater Disposal Systems	- No known contamination problems due to improper closure. - Approximately 80 known abandoned wells, - and probably more. - Up to 1/3 of developed land uses with on-lot wastewater disposal have not yet tied into sewer system.	- Initiate policy for Water and Sewer Divisions to require closure of wells and onlot wastewater disposal systems to be abandoned, concurrent with public service tie-in. - Provide public information on potential effects of improper closure of wells and on-lot wastewater disposal systems.
Wastewater	- Small possibility of contamination due to failing septic systems. - Unsewered area in So. Weymouth with development potential is close to Old Swamp River. - Some residences near Whitman's Pond are not served by sewer. - One known NPDES site in Hingham. - Sewer overflows in two areas add to cost of water treatment.	- Encourage property owners to tie into available sewers. - Proceed with plans to install sewers in South Weymouth. - Sewer remaining streets near Whitman's Pond. - Initiate intermunicipal contacts. - Provide public information on inflow problems related to illegal sanitary sewer connections. - Sewer Division to remove I/I and reduce surcharging in cooperation with MDC. - Planning Board to continue enforcement of site plan review and subdivision regulations requiring consideration of sewer capacity.
Road Salts	- Road salting by the State and the town in the vicinity of municipal wells results in raised sodium levels in drinking water during and after the winter.	- Restrict town road salting on additional streets in the vicinity of the ponds and wells. - Consider using other deicing chemicals. - Specify boundaries of watershed in Board of Health regulation No. 7.
Leachate	- No known sources of leachate contamination. - Many known cases of illegal dumping.	- Planning Board and Conservation Commission to continue enforcement of special permit process and Wetlands Protection Act. - Publicly impose santions in known cases of illegal dumping. - Provide public information on earth filling provision in Zoning Bylay. - Post signs in watershed area prohibiting dumping. - Open transfer station on Saturdays on trial basis. - Initiate regular community cleanup program. - Initiate intermunicipal contacts.
Surface Waste Impoundments	- No known waste impoundments which could contaminate supply sources. - Only small threat of future contamination, assuming enforcement of new State regulations.	- Prohibit surface waste impoundments designed to leach their contents to the ground as part of Watershed Protection zoning overlay district.
Underground Fuel Tanks	- Watershed contains many underground tanks for storage of potentially harmful fluids; most are older than 15 years. - Large areas still available for developments which are associated with use of underground tanks.	- Fire Dept. to continue program to identify and remove abandoned tanks for storage of flammable fluids; expand program to locate smaller abandoned fuel storage tanks. - Continue review of all applications for licenses and permits using information on wastershed boundaries, to be provided by Water Resources Protection Committee. - Adopt underground fuel storage bylaw.
Pesticides	- No known contamination from pesticides - Controlled pesticide applications will continue for right-of-way maintenance. - Domestic use may be threat due to prevalence of potential users in watershed.	- Board of Health to continue enforcement of town pesticide regulation. - Institute buffer zones for water supply protection; incorporate watershed boundaries into Regulation No. 14. - Provide public information on proper use and disposal of pesticides; contact state information bureau for assistance.
Fertilizers	- Whitman's Pond is polluted by high concentrations of nutrients.	- Provide public information on the effects of fertilizers on water quality. - Carry out phased program for restoration of Whitman's Pond.
Hazardous Wastes	- There is no safe method of disposing of household hazardous wastes. - Existing and future hazardous waste facilities are governed by state regulation, but other hazardous materials are unregulated.	- Provide public education on proper disposal of household hazardous wastes. - Hold household hazardous waste cleanup day, sponsored by Health Dept. & Environmental Protection Committee. - Adopt a Board of Health hazardous materials regulation.

TABLE 6-2 SUMMARY OF ZONING INCOMPATIBILITIES WITH WATERSHED PROTECTION

Zoning District	Potential Incompatibility	Recommendations
R-1	- Minimum lot area per residence is 15,000 s.f. - Associated land uses: household hazardous wastes, nonpoint source pollutants, underground fuel storage tanks.	- Increase minimum lot size as part of Watershed Protection District. - Adopt underground fuel storage bylaw. - Provide public information on potential contaminants.
R-3	- Associated land uses: underground fuel storage tanks, road salts.	- Adopt underground fuel storage bylaw. - Amend Board of Health Regulation No.7 on use of road salt.
R-4	- Associated land uses: underground fuel storage tanks, road salts.	- Adopt underground fuel storage bylaw. - Amend Board of Health Regulation No. 7 on use of road salt.
B-1	- Allowed land uses: car washes, service stations. - Allows 50% coverage with impervious surfaces, not including parking lots. - 13% of undeveloped wastershed land is zoned B-1 including 85 acres in Whitman's Pond drainge basin.	- Board of Selectmen to apply additional criteria in evaluating special permit applications for car washes. - Adopt underground fuel storage bylaw. - Require site plan review for business uses (if no other permits required) as part of Watershed Protection District.
B-2	- Allowed uses: car washes, service stations, auto and motorcycle rentals, auto and truck sales. - About 10 acres of undeveloped watershed land near Whitman's Pond zoned B-2.	- Rezone 10 acres near Whitman's Pond to B-1.
I-1	- Allowed uses: auto and truck sales, motor freight and bus terminals and yards, manufacturing and assembly including storage of flammable materials. - Allows 80% coverage with impermeable surfaces not including parking lots. - Three parcels zoned I-1 in sensitive areas.	- Rezone 3 parcels to PIP. - Prohibit noxious uses and require site plan review for industrial uses (if no other permits required) as part of Watershed Protection District. - Adopt Board of Health Hazardous Materials regulation. - Adopt underground fuel storage bylaw. - Amend Board of Health Regulation No. 7 on use of road salt.
PIP	- Allowed uses: manufacturing, bus terminals, storage and use of hazardous materials.	- Prohibit noxious uses as part of Watershed Protection District. - Adopt Board of Health Hazardous Materials regulation. - Adopt underground fuel storage bylaw.
POS-surplus property reuse	- Associated uses: road salts, underground fuel storage.	- Adopt underground fuel storage bylaw. Amend Board of Health Regulation No. 7 on use of road salt.
Floodplain	- Associated uses: filling within 100-year floodplain.	- Prohibit construction within 25 feet of surface water bodies as part of Watershed Protection District.

In addition to these issues, the following land uses, which should be prohibited or monitored, are not addressed at all by the town's existing zoning:

- o landfills/solid waste disposal
- o road salt storage, or dumping of salt-contaminated snow
- o underground storage of fuel oil, gasoline or chemicals
- o surface waste impoundments

To address these specific issues of importance to watershed protection, zoning and non-zoning bylaws should be adopted, and some regulations and practices for a number of town departments should be amended or initiated. These are outlined in the table and summarized in the following section.

WATERSHED PROTECTION PLAN

The elements of the watershed protection plan for Weymouth are detailed below. The recommended plan results from the analyses of the existing policies governing land use and zoning in Weymouth and represents the consensus of opinion of the town Watershed Protection Committee.

The protection plan is organized into the following categories: zoning overlay district; re-zoning sensitive areas; non-zoning bylaws and regulations; non-regulatory policies; public information program; and intermunicipal cooperation.

ZONING OVERLAY DISTRICT. It is recommended that the town adopt a Watershed Protection District as an amendment to the zoning bylaw. The district should be an "overlay" district with boundaries corresponding to the boundaries of the water supply watershed. These boundaries are defined by topography and are accepted as the physical limits of the ground area within Weymouth which contributes to recharge of the wells and the ponds. The term "overlay" means that the more restrictive provisions of the Watershed Protectin District would be added to, and take precedence over, the "underlying", or existing, zoning. The stated purpose of the district would be the protection of the public drinking water supplies of the town.* The Watershed Protection District for Weymouth should include the following provisions:

Allowed Uses. Those land uses permitted in the underlying existing zoning districts which do not pose a significant threat to water supply sources would be allowed "by right" in the watershed protection district, provided that all business and industerial uses would be subject to site plan review by the planning board. In addition, the density requirements for residential uses should be changed as follows: the minimum lot size should be 25,000 square feet, an increase from the existing minimum 15,000 square foot requirement. As an option, developers of residential subdivisions should be allowed to "cluster", or construct houses on lots no smaller than 20,000 square feet with a net density equivalent to 25,000 square foot lots, in exchange for dedicating the sensitive portions of the

*More than 50 Massachusetts communities have adopted similar zoning bylaws, and elements of them have been upheld in state district courts.

parcels to conservation uses; land dedications can be by writing deed restrictions or by granting easements to the town. (In addition, the town should consider a similar cluster provision for all of the residentially-zoned property to protect other fragile resources.)

Prohibited Uses. Land use activities which pose a significant threat to the supply sources should be prohibited in the district. Such incompatible uses include solid waste disposal landfills, surface waste impoundments designed to leach their contents to the ground, open road salt storage and dumping of salt-contaminated snow, and discharge to the ground or surface water of industrial and sanitary wastewaters. In addition, construction within 25 feet of the high water line of all surface water bodies should be prohibited for the purpose of preserving natural recharge areas for the supply sources.

RE-ZONING SENSITIVE AREAS. The uses allowed by current zoning for several large parcels of undeveloped property have been identified as inappropriate to the goals of watershed protection. Specifically, the Planning Board should re-zone all of the B-2 property in the watershed area to B-1. This would include only about 10 acres, but the change is important because of the proximity of the property to Whitman's Pond.

In addition, the I-1 property in South Weymouth, which drains to Old Swamp River, as well as the I-1 land adjacent to Whitman's Pond should be re-zoned to PIP. This would provide a location for future industrial development in the town while ensuring that it occurs in accordance with the standards and reviews for environmental protection required in PIP districts.

NON-ZONING BYLAWS AND REGULATIONS. To adequately address specific concerns identified in the study, the following bylaws have been recommended for adoption.

Underground Fuel Storage Tanks Bylaw. This bylaw would formalize the current practices of the Fire Department and expand the town's jurisdiction to regulate underground tanks for the purpose of water supply protection. The bylaw should require registration of existing and future underground tanks with capacities greater than 1,000 gallons. The tanks should be prohibited within the 100 year floodplain of the surface water bodies, within 100 feet of Whitman's Pond, Mill River and Old Swamp River, and within 400 feet of Great Pond and the town wells. The bylaw should require use of corrosion-proof or vaulted tanks or tanks with product sensors. Leak detection should be required by daily inventorying and by tank testing every five years until the twentieth year after installation and annually after that. Also, the owners should be required to develop spill and leak reporting and emergency cleanup programs.

The bylaw can be sponsored jointly by the Board of Health and the Planning Board. It should be administered by the Fire Department by expanding on the current practices for review of applications for licenses and permits to store flammable fluids. As a town bylaw, local town regulatory bodies such as the Conservation Commission will be able to use the underground fuel storage regulations for enforcement of environmental protection measures.

Hazardous Materials Regulations. To control the use of hazardous materials, including hazardous wastes, within the watershed area, the Board of Health should adopt a hazardous materials regulation. Similar to the provisions of an underground fuel storage bylaw, this should require registration, monitoring and emergency response procedures for all use of hazardous materials.

Wetlands Protection Bylaw. Currently, the town Conservation Commission is evaluating the benefits of sponsoring a local Wetlands Protection Bylaw which would add to its authority under the state Wetlands Protection Act. This bylaw has the potential to contribute significantly to protection of the water supply sources.

Amendments to Existing Regulations. In addition to the new bylaws recommended as part of the Protection Plan, amendments to two existing regulations would enhance their water supply protection capability.

Board of Health Regulation No. 7 prohibits use of salt for deicing within private developments in the watershed. It is recomended that the regulation be amended to specify the limits of the water supply watershed area.

Board of Health Regulation No. 14 regulates the use of pesticides in areas where they may affect public or private water supplies. The limits of watershed area should be incorporated into the regulation, and, in the future, restricted buffer zones around the supply sources may be added. This should be based on empirical data being collected currently by the state.

POLICIES OF TOWN DEPARTMENTS AND COMMITTEES. Practices and policies of a number of town departments can be modified to contribute to the goals of watershed protection. The following actions are recommended to satisfy specific needs identified in the land use analysis. They have been grouped by town department.

Department of Public Works, Water Division

1. Require proper closure of any existing wells to be abandoned concurrent with hooking up public water supply.

2. Post signs along roadways identifying watershed areas and prohibiting dumping.

Department of Public Works, Sewer Division

1. Require proper closure of existing on-lot wastewater disposal systems concurrent with sewer tie-ins.

2. Encourage homeowners to tie in to available sewers.

3. Construct sewers in unsewered areas in South Weymouth and in the vicinity of Whitman's Pond.

4. In cooperation with the Metropolitan District Commission, reduce infiltration and inflow in sewer system to reduce surcharging.

Department of Public Works, Highway Division

1. Expand the area of town currently restricted to road salting or use other deicing chemicals in these areas.

Department of Public Works

1. Open solid waste transfer station on Saturdays for a limited trial period.

Planning Board

1. Increase performance standards for earth removal.

2. Standardize runoff and erosion control criteria among Planning Board, Zoning Board of Appeals and Conservation Commission.

3. Strengthen the subdivision and site plan review regulations to take into account water quality impacts in the watershed.

Fire Department

1. Expand program for identification of abandoned fuel storage tanks to include underground tanks used for home heating oil.

2. Use information on watershed boundaries in reviewing all applications for licenses and permits.

Board of Health

1. Hold household hazardous waste cleanup day.

2. Initiate regular community cleanup programs.

Board of Selectmen

1. For review of special permits for car washes in watershed area, use protective criteria to ensure that all runoff from the site will be discharged to an available storm sewer.

PUBLIC INFORMATION PROGRAM. One recurring recommendation for an effective program to protect water supplies is the provision of information to the public on the effects of certain land use activities on the watershed. This is necessary because, in general, the public is unaware of the relationship between individual actions and environmental consequences. Information could be provided in a number of forms. These include leaflets, news articles and advertisements, talks at neighborhood meetings, local cable television, or publication of fact sheets on some of the more significant aspects of the watershed protection study.

The following areas of public information were identified in the land use analysis for this study. They complement the public education program which the Whitman's Pond Association plans to conduct as part of the Restoration Plan for the pond.

1. Potential groundwater impacts related to improper closure of wells and on-lot wastewater disposal systems.

2. Causes and effects of inflow in sanitary sewers.

3. Earth filling provision included in the Zoning Bylaw.

4. Proper use and disposal of household pesticides, may request assistance from state information bureau on pesticides.

5. Effects of fertilizers on water quality, and guidelines for proper use of fertilizers.

6. Proper disposal practices for household hazardous wastes.

7. Water conservation.

INTERMUNICIPAL COOPERATION EFFORTS. Since about 28 percent of Weymouth's water supply watershed extends outside the boundaries of the town into Hingham, Rockland, Holbrook and Braintree, it is important that officials of these communities are informed of the watershed protection efforts being undertaken by Weymouth. A continued program of open communication will allow the Planning Board, the Conservation Commission and other town departments to comment on the activities occurring in these neighboring towns which may affect Weymouth's supply sources. The town should include neighboring community officials in any public information mailings and invite representatives to presentations or other special events. The following specific areas of concern for intermunicipal cooperataion were identified in the land use analysis of this study:

1. Control of non-point sources of water quality degradation, and maintenance of adequate natural recharge areas.

2. Monitoring of wastewater discharges.

3. Monitoring of landfilling and dumping activities.

A memorandum of understanding has been approved between Weymouth, Hingham, and Rockland, which will allow for coordination among the towns on impacts to the Old Swamp River portion of Weymouth's watershed. Weymouth should consider entering into a similar agreement with Braintree and Abington concerning the Mill River portion of the watershed.

WHITMAN's POND RESTORATION PLAN. All of the efforts being undertaken as part of the Whitman's Pond Restoration Plan will contribute to the goals of the Watershed Protection Plan. Specifically, the public information program, and the source control program will enhance the quality of the water supplies.

APPENDIX A

GLOSSARY

AERATION: the bringing about of intimate contact between air and water.

AQUIFER: geologic formation, group of formations, or part of a formation that contains sufficient saturated permeable material to yield significant quantities of water to wells and springs.

CALCIUM: an element which occurs in water in the form of a compound and which is the most common cause of hardness. (Ca).

CHLORINATION: the application of chlorine to water, usually for disinfection purposes.

CONE OF DEPRESSION: (or drawdown cone): a roughly conical concavity in the potentiometric surface around a pumping well.

CONTAMINATION: a general term signifying the introduction into water of microorganisms, chemicals, wastes, or sewage, which renders the water unfil for its intended use. Usually considered to imply the presence, or possible presence, of disease producing bacteria. A specific type of pollution.

CORROSION: the gradual deterioration or destruction of a substance or material by chemical action. Usually thought of as the oxidation or rusting of iron.

DISINFECTION: the killing of the larger portion (but not necessarily all) of the bacteria by means of chemicals, heat, ultraviolet light, etc.

DISPERSION: the act of spreading or distributing a dissolved substance from a fixed or constant source; or the process by which a dissolved substance spreads out from a constant or fixed source.

DISSOLVED SOLIDS: solids that are present in solution.

DRAINAGE AREA: the land area which contributes surface water flows to a water body. Also called watershed or catchment area.

EFFLUENT: water flowing out of a reservoir, basin, or treatment plant or part thereof.

EVAPORATION: the direct return of water vapor into the atmosphere from a land or water surface.

FILTER, RAPID SAND: a filter used in the purification of water where water, which has been previously treated by coagulation and sedimentation, is passed downward through a filtering medium, consisting of a layer of relatively coarse sand or prepared anthracite coal or other suitable material, usually from 24 to 30 inches thick, resting on a supporting bed of gravel or a porous medium such as carborundum.

FILTRATION: the process of passing a liquid through a filtering medium (which may consist of granular material such as sand, diatomaceous earth, or specially prepared paper) for the removal of suspended or colloidal matter usually of a type that cannot be removed by sedimentation.

HYDROLOGIC CYCLE: the continuous circulation of water between the ocean, atmosphere and land.

IMPERVIOUS: a term applied to a material through which water cannot pass or passes with great difficulty.

INFILTRATION: (1) the flow or movement of water through the pores of a soil or other porous medium. (2) the absorption of liquid water by the soil, either as it falls as precipation or from a stream flowing over the surface. Also called seepage.

INFLUENT: water flowing into a reservoir, basin, or treatment plant or a part thereof.

IRON: an element which occurs in nature in the oxide form. Iron compounds, such as sulfates and chlorides, often are used as coagulants. As a compound it exists either in the divalent (ferrous) state (Fe++), or the trivalent (ferric) state (Fe++).

LEACHATE: the liquid derived from the leaching of buried refuse in sanitary landfills and dumps by percolating water derived from rain or snowmelt. It frequently contains large numbers of inorgaanic contaminants, high values for total dissolved solids, and may contain many organic contaminants.

MANGANESE: an element sometimes found in a natural water, often accompanied by iron, which imparts black stains to plumbing fixtures and clothing, Mn.

MGD: million gallons per day; a rate of flow.

PERCOLATE: water moving by gravity through pore spaces of unsaturated geologic material.

PERMEABILITY: the capacity of a porous medium for transmitting water; perviousness.

PERVIOUS: a term applied to a material through which water can pass with relative ease.

PLUME: a relatively discrete body of contaminated groundwater originating from a specified source(s) and influenced in its movement by such factors as the local groundwater flow pattern, specific gravity and solubility of the contaminant, the subsurface geology within the zone of saturation, and the influence of pumping wells.

POLLUTION: the addition of sewage, industrial wastes, or other harmful or objectionable material to water. A general term that does not necessarily signify the presence of disease producing bacteria.

POTABLE WATER: water which does not contain objectionable pollution, contamination, minerals or infection, and is considered satisfactory for domestic consumption. Suitable for drinking purposes.

PRECIPITATION: (1) the total measurable supply of water received directly from clouds, as rain, snow, hail, and sleet; usually expressed as depth in a day, month or year and designated as daily, monthly, or annual precipitation. (2) the phenomenon which occurs when a substance held in solution passes out of solution into solid form.

RECHARGE: the entry into the saturated zone of water made available at the water table surface, together with the associated flow away from the water table within the saturated zone.

RECHARGE AREA: that portion of a drainage basin in which the net saturated flow of groundwater is directed away from the water table.

RESERVOIR: a pond, lake, tank, basin or other facility, either natural in its origin or created in whole or in part by the building of engineering structures, which is used for the storage, regulation, and/or control of water.

RUNOFF: (1) that portion of precipitation which does not return to the atmosphere through evapotranspiration nor infiltrate the soil to recharge groundwater, but leaves the hydrologic system as streamflow; also (2), that portion of precipitation delivered to streams as overland flow to tributary channels.

SATURATED ZONE: the subsurface zone occurring below the water table where the soil pores are filled with water, and the moisture content equals the porosity.

SAFE YIELD: the amount of water that can be withdrawn annually from a groundwater basin without producing an undesirable result. Undesirable results include depletion of groundwater reserves, intrusion of low quality water, contravention of water rights, and others, such as depletion of streamflow and land subsidence. Safe yield is an idea only; it can be neither measured nor expressed quantitatively and correctly. Properly applied, the concept can be a useful tool.

SOFTENING: the process of removing from water certain mineral substances, principally calcium and magnesium compounds, which are the cause of hardness of water.

TRANSPIRATION: the process by which plants dissipate water into the atmosphere through their leaves and other surfaces.

WATERSHED: the area of contribution to a surface water body, defined by topography. See drainage area.

WELL, DRILLED: a well that is excavated wholly or in part by means of a drill (either percussion or rotary) which operates either by cutting or by abrasion. The materials that are excavated are brought to the surface by means of a bailer, sand pump, hollow drill tool, or by a hydraulic self-cleaning method.

WELL, GRAVEL WALL: a type of well in which the sand adjacent to the well screen has been removed and replaced by gravel.

Sources: Mass DEQE, Groundwater Quality and Protection, A Guide for Local Officials, 1982; New England Waterworks Association, Introduction to Water Supply and Water Quality

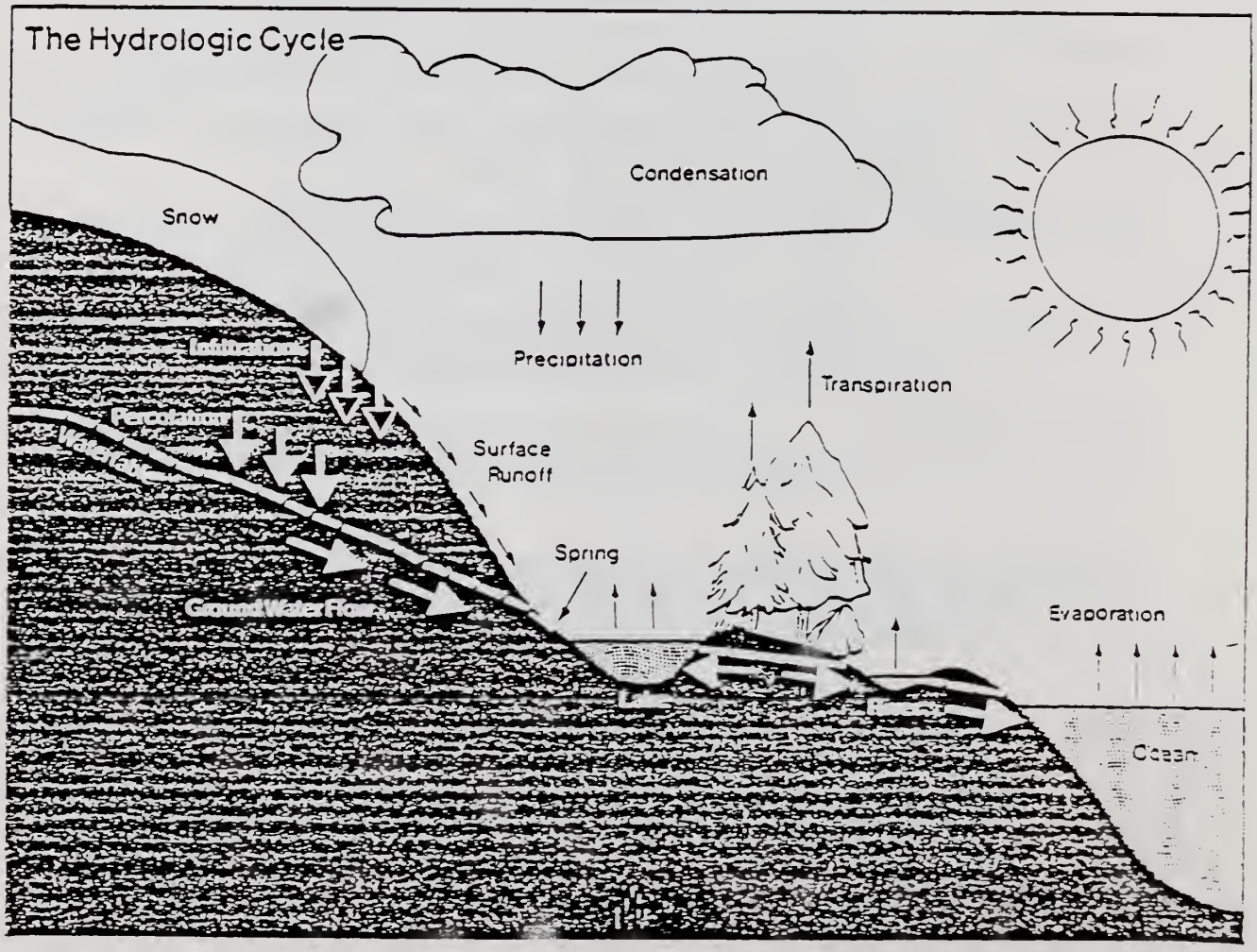
APPENDIX B
BASIC HYDROLOGIC PRINCIPLES

Hydrology is the study of water - both surface water (ponds, rivers, brooks, etc) and groundwater (water stored in subterranean rocks and soil deposits). This appendix provides an overview of the principles that govern the quantities of water available for drinking supplies and some of the relationships between surface water and groundwater.

THE HYDROLOGIC CYCLE

Precipitation in the form of rain and snow is the ultimate source of all groundwater and surface water supplies. But only a small percentage of all precipitation is available for supplies. Of the 40 inches of annual average precipitation in Massachusetts, approximately 60 percent returns to the atmosphere. There are two main processes by which precipitation is released into the atmosphere. One way, called transpiration, is through openings on the surface of leaves, known as plant photosynthesis. The second process, evaporation, is water changing in air from a liquid to a vapor. The total loss due to evaporation and transpiration is known as evapotranspiration. The remaining 40 percent of precipitation is stored in surface-water bodies, such as ponds, lakes and oceans, or will infiltrate into the soil and become groundwater (Figure 1).

FIGURE 1



GROUNDWATER AND SURFACE WATER

The relationship between surface water and groundwater is important to understand. An itinerant molecule, water has no distinct beginning or end in the cycle. One way of understanding the relationship better is to think of lakes, rivers, and wetlands as areas where the water table intersects or lies above the land surface.

Surface water can provide groundwater recharge (allow significant amounts of water to move into the ground) as well as receive groundwater discharge. The direction of flow between surface-water and groundwater depends upon the relative water elevations in the ground and the surface water body, the type of material underlying the surface-water body, and the slope of the water table. Streams and wetlands can recharge groundwater during periods of flooding. Wetlands and floodplains store excess water and release it slowly into the ground after the flood peak passes.

Recharge can be induced from surface waters into nearby pumping wells (Figure 2). When groundwater is pumped from an aquifer, the water table around the well is lowered. The area of this drawdown, called the cone of depression, expands as a function of pumping rate, recharge, and soil permeability. Surface water will be drawn into the well if the cone of depression intersects a stream, lake, or wetlands (Figures 2 & 3).

FIGURE 2

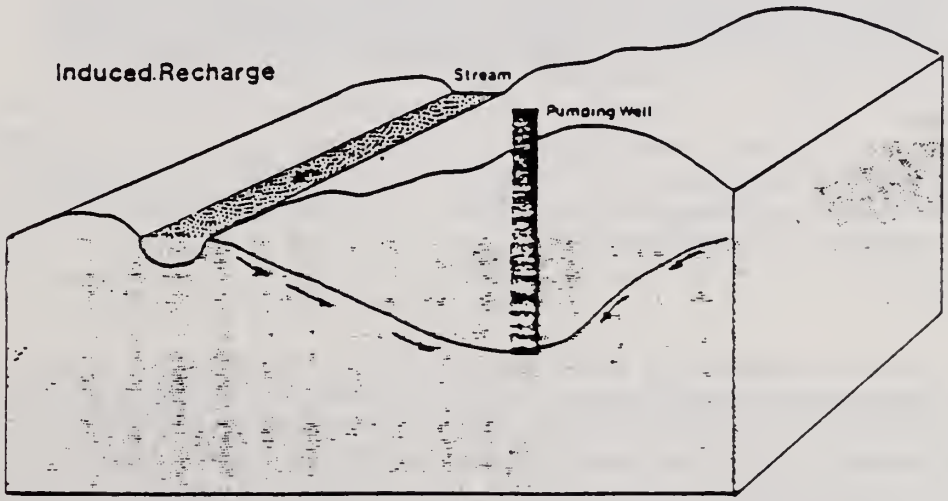
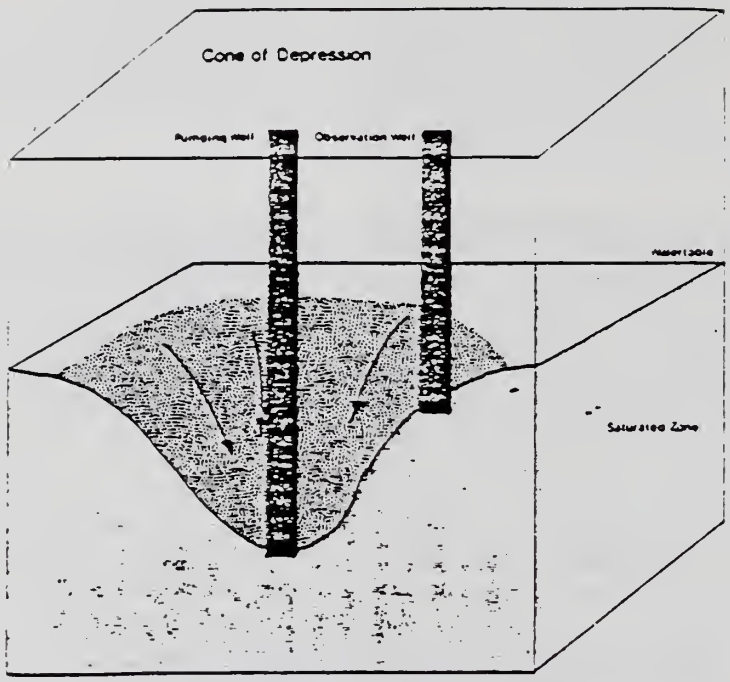


FIGURE 3



The amount of water that is actually stored as surface or groundwater depends on a number of factors. Conditions that encourage a high infiltration rate, where water readily penetrates the ground, include coarse-grained soils, well-vegetated land, and low soil moisture. Frozen-ground conditions, pavement, or impermeable soil, on the other hand, result in a high rate of runoff, where water flows over the land and empties directly into streams and rivers. High runoff, coupled with intense rainstorms, often causes flooding. Principles of infiltration and overland flow are described below.

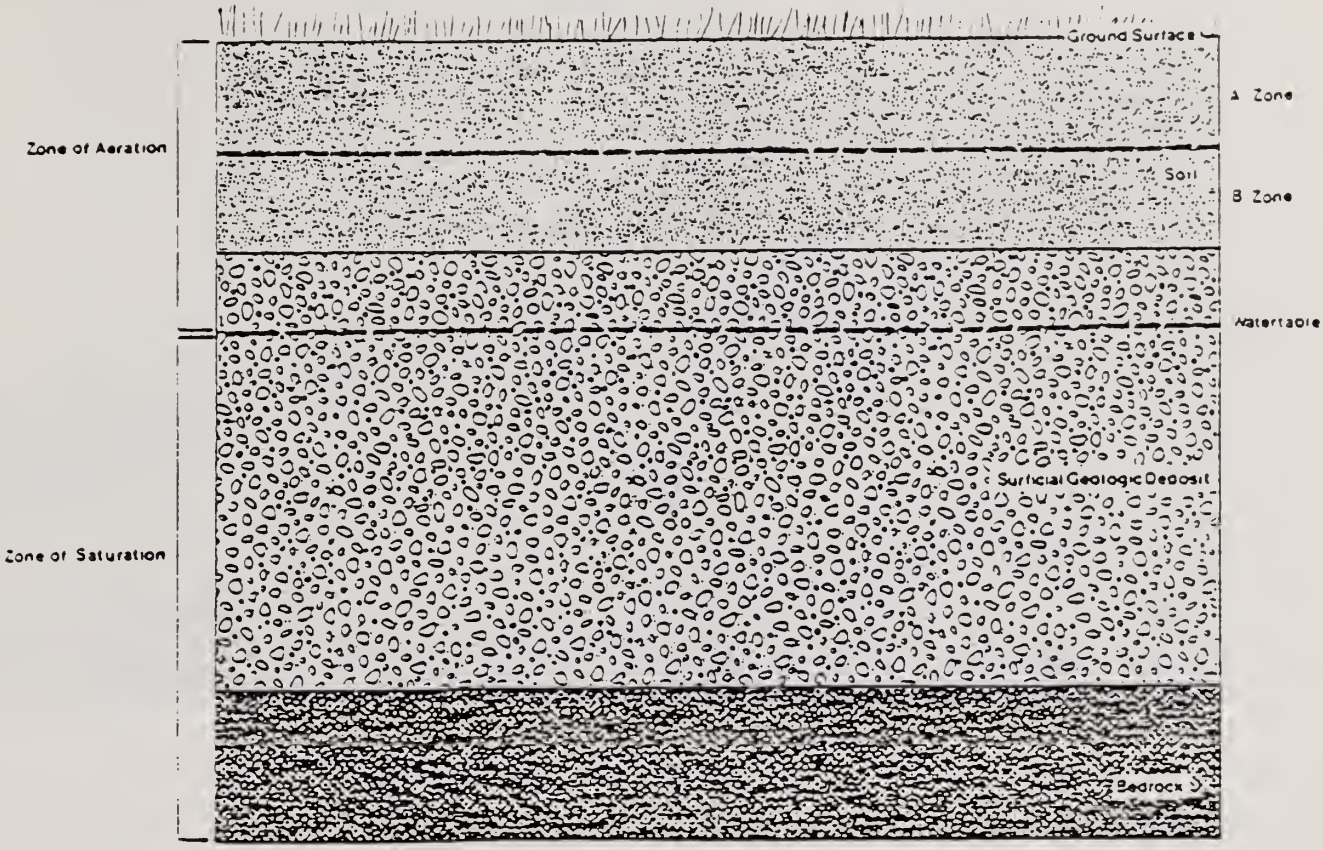
INFILTRATION

Water from precipitation that does not flow overland to surface water bodies or storm drains percolates (travels downward) through the soil and accumulates in the interstices (pore spaces) between soil particles. Some soils are porous, i.e., they have a large volume of spaces between particles and can store a lot of water. The shape and uniformity of a soil's grain size will determine its porosity, the amount of water that can be stored.

The zone of aeration, the upper layer of soil, where percolation occurs, contains air as well as water. The level below which all of the pores are filled with water is called the water table (Figure 4). The level of the water table varies seasonally and annually and can fluctuate up to several feet per year. This fluctuation is, of course, caused by the amount of rain and snow, but a recent study shows that it is even more affected by seasonal changes in the rate of evapotranspiration.

FIGURE 4

Ground Water Zones

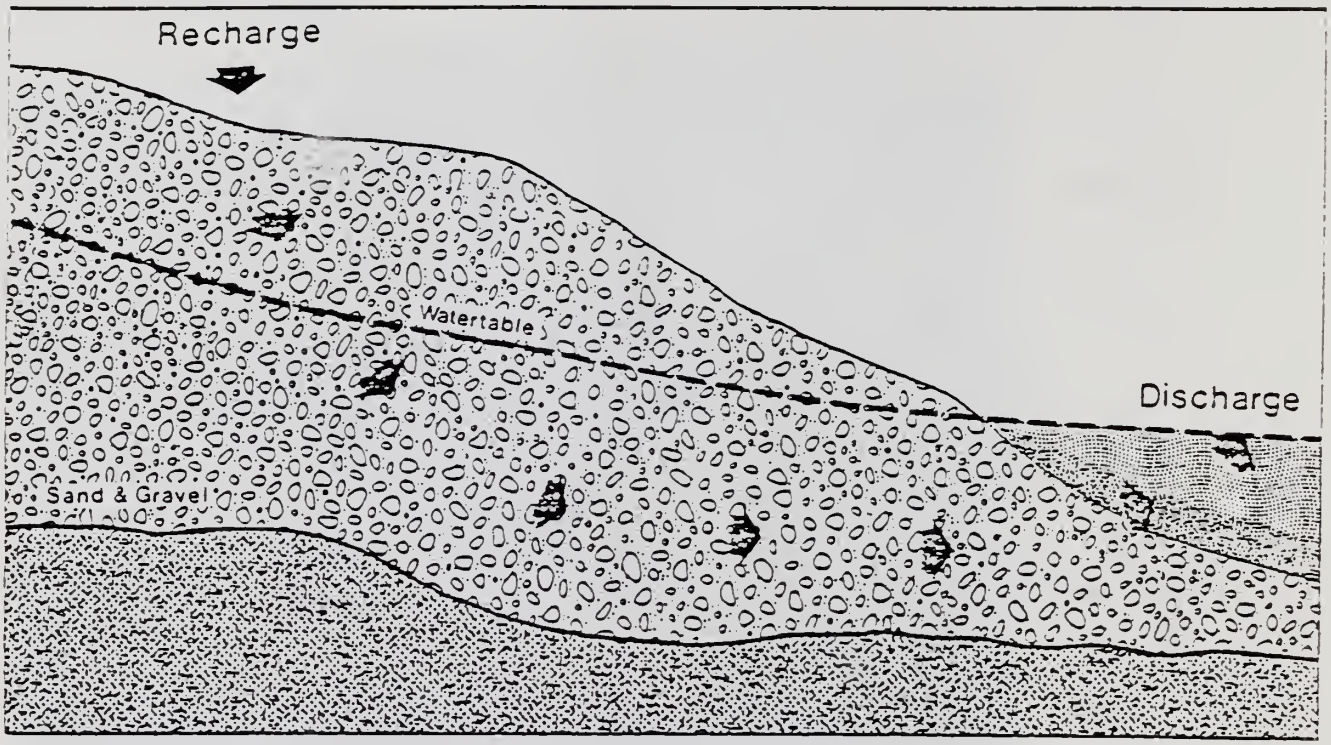


If the saturated soil occurring beneath the water table, called the zone of saturation, is thick and permeable, it constitutes a water-bearing formation known as an aquifer. An aquifer is a formation, group of formations, or part of a formation that contains sufficient saturated permeable material (sand, gravel, or porous rock) to yield significant quantities of water to wells and springs.

Once water infiltrates the ground and forms an aquifer, it is not just stored there but moves by gravity toward areas where it discharges to a surface-water body. The water table generally follows the shape of the topography. Groundwater flow rates average beteen 5 feet per day and 5 feet per year. Slower movement will occur in tightly compacted silt and clay, of course, and faster rates of flow have been recorded in bedrock fractures, extremely coarse soil, or near pumping wells.

Groundwater recharged on land flows through the ground from high elevations into the ocean, rivers, lakes, and wetlands at lower elevations (Figure 5). Groundwater discharge also can appear as springs, common on hillsides. Groundwater may encounter a layer of impermeable rock or clay where it becomes "perched" or trapped near the surface. It may accumulate there in quantities that may be substantial enough to supply one or two households.

FIGURE 5



OVERLAND FLOW

Surface waters are recharged by groundwater discharge, as described in the previous section, by direct precipitation, and by runoff from surrounding ground surfaces.

Water that is not infiltrated flows downhill over the ground surface. As water moves over the surface it gradually is collected in the rills or small channels, which join to form larger channels, which also join. Each rill, brook, creek or river receives the water from an area or tract of land surface that slopes down toward the channel. Channels, therefore, occupy the lowest part of the landscape. The ridges of the land surface-that is, the rim separating the land that drains into one stream from the land that drains into another-is called the divide. The area enclosed by the divide is called the drainage area or watershed. The drainage area or drainage basin above any particular point refers to the area bounded by watershed divides from which water drains or flows downhill to or past the point in question.

In forested areas and other well-vegetated places, water flowing over the surface is never seen. Only small parts of a basin, those in swales, draws, and low-lying ground near the channel, experience overland or surface flow. When there is a moderate amount of rainfall, these small areas near the rill heads quickly become saturated and the infiltration rate approaches zero. Thus, all rainfall in such areas runs off immediately because the local soil is saturated. In many places, swale bottoms at the headwater tips of channels are moist, often even wet, and would infiltrate little or no water if additionally wetted by rains. This is because the local water table is near the surface and capilarity provides water to the near-surface soil. The area of contribution to surface runoff, then, is localized near the upstream tips of the minor channels and rills and along the channel. As rain persists, the percentage of the total basin that contributes to surface runoff increases. The area of contribution can be viewed as a bulb or local zone near the head of every rill, expanding and contracting over time.

APPENDIX C

HISTORY OF PUBLIC WATER SUPPLY IN WEYMOUTH

This Appendix provides a brief description of the development of Weymouth's water system. The history is presented within the general context of the town's growth but also touches on the development of some water-related businesses within the community as well as the previous uses of the current supply sources. The chapter also focuses on past instances of controversy over protection of the supply and on several water emergencies. The material is included in the report to provide additional insight into the structure and operation of Weymouth's water supply system, as the current study seeks to draw on the town's past experience in meeting the changing water demands of its citizens.

WEYMOUTH'S EARLY YEARS

From the time of the original settlement of Wessagusset in 1622 to the early 1800's, private wells were the primary source of water for the inhabitants of Weymouth. The population of the town grew slowly during this early period, from an estimated 1,000 in 1643 to 1,803 recorded in the 1800 census (Nash 1885). The first official map of Weymouth, which was drafted by Lemuel Humphrey in 1795, is noted for its sparce two roads, two churches, five schoolhouses, and some taverns (Weymouth 350).

Several industries were already established by the 1800's and two of these, milling and bog iron mining, were related to the town's water resources. Up to five grist and saw mills operated on the Mill River from as early as 1669 (Kevitt 1981). In fact, since its settlement, the town had been noted by the English for its excellent mill privileges (Nash 1885).

Mining of iron ore from the bog iron deposits found in several swamps and ponds had been a prosperous business for Thomas Hobart of Abington who began in 1771 by paying the town 40 shillings per ton to mine Great Pond. He was then granted a 30-year lease in 1773 to mine Whitman's Pond and Whortleberry Pond for a fee of 60 pounds per year (Kevitt 1981).

WEYMOUTH AQUEDUCT CORPORATION

About 1820, Weymouth's first water system, a private enterprise, was begun by Micah Raymond. Because he was encountering salt water in the wells at his house on what is now Commercial Street, Raymond stoned up and covered in a spring on his Washington Street property and laid pipes to his own house and to five others in the vicinity. He formed the Weymouth Aqueduct Corporation in 1825 which was authorized to hold real estate and personal estate. The initial water rents were based on a fee of $5.00 per faucet.

Over the next 30 years other springs were added to the system, which apparently supplied a considerable number of customers until about 1855 when some of the pipes were removed and the water was shut off. It was 1873, however, before the corporation was officially dissolved by the state legislature. Despite several attempts to supply water from Great Pond, the Weymouth Aqueduct Corporation is believed to be the only system to actually supply customers with water prior to construction of the present system (Stevens 1923).

GROWTH OF THE TOWN

In the early 1840's Weymouth was still a small rural village (Kevitt 1981) with a population of about 3,700 (Nash 1885). But, throughout the next 50 years, "urbanization" of the town, characterized by a growing population and the introduction of several industries, would result in a demand for public services. For example, the character of the town, and Jackson Square in particular, was to be affected significantly by the establishment of the Weymouth Iron Company in 1840.

First, the company bought a large strip of land extending from Whitman's Pond (which was then half its present size) to the Back River as well as the land or flowage rights around the pond. Several dams, a canal, wharves and buildings were constructed by the company (Kevitt 1981). Their water rights were considered among the best in the state (Nash 1885). Perhaps resulting in as far-reaching an impact as the construction of the industrial complex was the company's attraction of a relatively large number of workers who relocated their families to the town which had previously been about all natives (Kevitt 1981). By 1850, the census reported the population at 5,369 (Nash 1885), an increase of 30 percent in just ten years.

The shoe industry was also established in Weymouth during the early 1800's. Though not dependent upon water for the manufacturing process, the prosperous industry is likely to have stimulated town growth because of the numbers it employed. The shoe industry started back in 1808 (and continued for 165 years to 1973). After that time, Weymouth became largely a one-industry town. Although never the largest shoe-producing town in the state, its reputation for high quality boots and shoes spurred the growth of the business such that half of the population of 1837 is estimated to have been employed in making shoes (Kevitt 1981).

In the 1870's there were 75 firms in the town manufacturing shoes and related products (Kevitt 1981). By the year 1873, the population of the town was more than 9,000 (Nash 1885) and Weymouth continued to prosper during the country-wide hard times because of the increased demand for Army shoes and boots (Kevitt 1981).

On a smaller scale, ice harvesting was carried out in Weymouth from 1874 to the 1920's when electric refrigerators were developed. This seasonal activity, which lasted for only four to six weeks in the winter, was common in most New England towns with a suitable pond or body of water. Great Pond supported the three ice houses of the South Boston Ice Company which exported the majority of its ice to four major southern cities. Local demand was met by J.F. and W.H. Cushing who cut and stored ice in their two ice houses on Whitman's Pond (Kevitt 1981).

PUBLIC WATER SYSTEM

The decade of the 1800's, in which Weymouth's shoe industry reached its peak, was the period during which the water system as it is currently known underwent its initial development. Around 1880, the individual villages in the town were apparently taking steps to provide themselves with their own water supplies. In 1880, with a town population of 10,570 (Nash 1885), A.J. Richards posed the first proposal to create a town-wide public water system and supply. At his bidding, that year Town Meeting voted to petition the State Legislature for the right to take Great Pond water, but the motion to establish a committee to engage an engineer and explore the water supply question was tabled because of opposition (Stevens 1923).

The following year the General Court passed legislation enabling Weymouth to issue bonds for construction of a water system, and a town committee was formed which commissioned M.M. Tidd, a prominent water supply engineer, to prepare an official survey and cost estimates for the Weymouth Water Works. His report was presented at the 1882 Town Meeting, but it was not until 1883," after the driest August... ever recorded in this locality...(that) quite naturally we find the voters of Weymouth assembled in special meeting on September 18 to vote on the acceptance of Chapter 174 of the Acts of 1881, entitled An Act to Supply the Town of Weymouth with Pure Water," (Stevens 1923).

By 1885, significant progress had been made. The Water Commission had been established to oversee the administration of the new system and the initial waterworks had been put into place. The system consisted of Great Pond as the source, 34 miles of distribution pipe (the total length of streets in the town was only 64 miles); the Reed Avenue standpipe, a wrought iron tank with a capacity of 2 million gallons; the steam-driven pump station on Hollis Street; and two buildings used for equipment storage, shop space and a stable (Stevens 1923).

There were at that time 475 house services. These consisted of asphalt-lined wrought iron pipe and were layed for 15 cents per foot or $1.00 if in ledge. In the next few years the system was continuosly expanded, including numerous cases of land takings and easements (some prompting law suits), until in 1885, Weymouth's water system reached 2,183 homes.

WATER SUPPLY PROTECTION

Since the year 1884, the Water Commission had had the authority to take all lands necessary for protection of the quality of water in Great Pond (Index to Town Meeting Records), but no action had been taken by 1900 perhaps because Town Meeting had never appropriated the funds for it.

Although it functioned as a public water supply source, until 1903, Great Pond was used "to a considerable extent" as a recreational resource. Boating, gunning and fishing were allowed without any apparent restrictions, and boat rentals were a firmly established business (Stevens 1923). Control of these activities, as well as pollution due to horse-drawn ice cutting machinery, became issues in the town. Two different approaches were taken in response.

Around 1900, the Board of Water Commissioners and the Board of Selectmen petitioned the state legislature for authorization to take land "by purchase or otherwise on the shore around Great Pond for prevention of pollution" (Index to Town Meeting Records). Also around 1900, the Board of Water Commissioners petitioned the State Board of Health to make "certain rules and regulations for the protection of the waters of the pond." Realizing the danger in the continued recreational use of the reservoir, the Board of Health in 1903 issued rules prohibiting boating, fishing or ice cutting without special permit from the Water Commission (Stevens 1923). Boat letting was not allowed, and permits were not transferrable. However, the Commission continued until 1911 to issue these permits to residents without any further restrictions.

During this period, controversy over the conditions of the pond continued, with some wishing greater restrictions and others demanding the town lift those already imposed. In 1910, the Town Meeting warrant contained one article to empower the Water Commission to purchase the land adjacent to Great Pond, and another instructing the Commissioners not to issue permits for boating and fishing. Both motions were overturned; the latter was lost twice more that year at subsequent special town meetings.

The following year, however, in 1911, the Water Commission voted to prohibit all "boating or entering on Great Pond" (Stevens 1923). In 1915, 1,500 tiny pine trees were planted by the Water Commission for forestation of the watershed. But it was 1927 when the town finally voted $31,500 for taking land around the pond, thus ensuring its protection (Stevens 1923).

GROWTH OF THE SYSTEM

In 1930, as the Depression engulfed the country, the town was taking further action to ensure a high quality water supply. Diseases such as cholera and typhoid were still significant problems in parts of the country around the turn of the century (EPA 1980) and the recent urbanization of the town may have stimulated the Water Commissioners to take advantage of the relatively recent advances which had been made in water treatment technology.

It was in 1930 that Mr. Stevens, the Water Superintendent, was paid an additional $500 to prepare the plans for a proposed filtration plant. The request had been rejected in 1913, but in 1933, the town voted to proceed with construction of the 4 mgd rapid sand filtration plant which was subsequently completed in 1936. Three years later, the State Board of Health reported the continued excellent quality of the treated water (Beane 1967).

The unusually hot summer of 1941 revealed low pressure at Great Hill and individual wells on Hingham Avenue went dry. In response, the town engaged the consulting firm of Weston and Sampson to report on the needs of the water system. The following year, as recommended by the study, the town began a groundwater exploration program to meet the greater water demands of a larger population. The Circuit Avenue well was constructed in 1944.

The years between 1945 and 1960 marked the period of fastest growth for the town. During this time, the population increased 71 percent, from approximately 28,000 to over 48,000 (CDM 8/79). This post-war boom was due largely to a trend of out-migration from cities to suburbs, to Weymouth's location within the Boston metropolitan region, and to its ability to offer residential opportunities for both the Boston and Quincy employment centers. The attraction of the town was further enhanced by the construction of Route 3 and the Southeast Expressway (CDM 8/79) and, no doubt, by Weymouth's plentiful land and other resources.

The Water Commissioners responded to the growing needs of the town by initiating a vigorous program of construction of new water mains, wells and storage tanks as summarized here:

1947	Essex Street standpipe begun
1951	Main Street well
1957	Park Avenue standpipe and Great Hill standpipe
1959	Whitman's Pond well
1963	Winter Street well and expansion of Great Pond Filtration Plant (Beane 1967)

The incorporation of the Weymouth Department of Public Works took place in 1956. This action brought the Water Department, along with the Highway, Parks and Trees, Engineering, and Sewer Divisions all under one jurisdiction. The Water Division assumed responsibility at this time for the administration of the system.

There had been droughts in 1949-50 and one in 1957 which had lowered the surface water elevation of Great Pond more than 7'4", but the lack of rainfall in 1964 prompted drastic actions to maintain the water supply: permission was obtained from the State Department to build a temporary pumping station, with filtration, to pump Whitman's Pond water into the system (after this was done it was estimated that Great Pond was within one day of running dry); a former temporary well site off Neck Street was put into operation; a six-month connection to the City of Quincy's supply was made; and a moratorium on permits for new building construction was initiated (Beane 1967).

The following year brought no relief. Less than 12 inches of rain fell in 1965, 30 inches below the average, and produced the worst drought ever experienced by the town. The water level in Great Pond dropped 17'9" (its total depth is 20 feet) below full pond level (Beane 1967). The town used the emergency system set up previously and applied for membership in t he Metropolitan Water System (Beane 1967). Additional measures taken were the construction in 1965 of the Washington Street pump station and a 20-inch main to Great Pond to divert both water from Old Swamp River entering Whitman's Pond and the groundwater from Whitman's Pond well. This was followed in 1967 by reconstruction of the filtration plant to treat the additional water supply.

Since the late 1950's, Weymouth's population has continued to increase but at a moderate pace, reflecting demographic trends of smaller familiies and the advent of multi-unit dwelling construction (CDM 8/79). This form of residential growth was sought by the town in 1969 when, under pressure from developers, the town passed zoning bylaw amendments re-designating large parcels of land as available for construction of multi-family residences.

In 1975 the 4.0 mgd Winter Street Water Treatment Plant was constructed for removal of iron and manganese from the Winter Street, Circuit Avenue and Main Street wells (all in Mill River valley). The town has commissioned a continuing series of engineering reports and is involved in carrying out a phased program of water main expansion and system maintenance.

Despite the steady growth of the system, water supply problems have continued to rise periodically. In the early 1970's, Weymouth experienced a new type of problem: the Main Street well became contaminated by an underground gasoline leak in the vicinity of Route 3 and was unable to be used for approximately two years while the toxic hydrocarbons were pumped from the aquifer. Water from the well is now being pumped into the system again, but only because of the availability of aeration at the Winter Street water treatment plant.

Also, the years between 1979 and 1981 brought another period of drought. The town's voluntary ban on the use of outside water, which resulted in a 10 percent reduction in water consumption, was enough to meet the short-term demands.

FUTURE PROSPECTS

A report completed by Camp Dresser and McKee in 1981 found Weymouth's supply system adequate to meet demands to the year 2000 and possibly to 2020. According to the town's 1977 Housing Plan, further substantial increases in population appear unlikely due to a limited number of large tracts of vacant land and to mixed feelings about apartments in the town. This is substantiated by the 1981 interim population projections prepared by the Metropolitan Area Planning Council which show no increases over the next 30 years.

In another area, though, the town has recently identified the attraction of industrial development as a much-needed solution to the problem of its limited tax base which has resulted from the restrictions of Proposition 2-1/2. As these and other proposals arise, it is advisable that feasibility studies conducted include an evaluation of such development's potential effects on the quality and quantity of the town's water supplies.

Undoubtedly, long-term problems of accidental chemical contamination and shorter-term drought emergencies will continue to occur in the future. In undertaking the current water supply protection study, Weymouth has indicated its recognition of the need for initiating long-term protection measures and its desire to continue its successful history of providing safe drinking water to its residents.

APPENDIX D

REFERENCES

American Society of Civil Engineers; Groundwater Management; ASCE - Manuals and Reports on Engineering Practice - No. 40; Headquarters of the Society; New York, NY 1972.

Beane, Sydney C.; The History of the Weymouth Water Works; A Talk Given to the Weymouth History Study Group; 1967.

Camp, Dresser and McKee, Inc.; Town of Weymouth, Massachusetts Water System Update Report; August 8, 1979.

Camp, Dresser and McKee, Inc.; Town of Weymouth, Massachusetts Water Distribution System Storage; November 19, 1980.

Camp, Dresser and McKee, Inc.; Washington St. Pumping Station Evaluation; October 30, 1981.

Camp, Dresser and McKee, Inc.; Water Transmission System Evaluation; September 17, 1982.

Camp, Dresser and McKee, Inc.; Town of Weymouth, Massaschusett; Water Systems Evaluations; November 17, 1982.

Carlson, Jeffrey; Massaachusetts Department of Food and Agriculture, Pesticide Bureau; Personal Communication; September 2, 1983.

Chelton, Donald; Project Engineer, Metcalf & Eddy, Inc., Personal Communication; January 1984.

Cicchese, Steve; U.S. Environmental Protection Agency, Region I, Division of Hazardous Wastes; Personal Communication; August 29, 1983.

Coffin and Richardson; Hydrology Study of the Libbey Industrial Park Area, Weymouth, Massachusetts; Prepared for the Weymouth Planning Board; March 1978.

Connor, James; Chief, Weymouth Fire Department; Personal Communications; October 28 and December 6, 1983.

Coyne, Michael T.; Water Division, Weymouth Department of Public Works; Personal Communications; June 17 and 18, August, November 1983.

Donlan, Mr.; Massachusetts Department of Environmental Quality Engineering, Lawrence Experiment Station; Personal Communication; February 1984.

Executive Office of the President, Bureau of the Budget; Standard Industrial Classification Manual; prepared by the Technical Committee on Industrial Classification, Office of Statistical Standards, U.S. Government Printing Office; Washington, DC; 1957.

Fuqua, Roderick; Principal Planner, Weymouth Planning Department; Personal Communication/Update of land use and zoning maps; July 1983.

Goodrich, Sandra; Massachusetts Department of Environmental Quality Engineering, Division of Hazardous Wastes, Industrial Outreach Program; Personal Communication; August 29, 1983.

Goodwin, Harold; Plant Superintendent, Water Division, Weymouth Department of Public Works; Personal Communications; June 17 and December 16, 1983.

History of Weymouth, Massachusetts, in four volumes; Volume I - Historical; Published by the Weymouth Historical Society; 1923. History of the Weymouth Water Works, by Fred O. Stevens.

Institute for Conservation Archaeology, Peabody Museum, Harvard University; Final Report: Phase I Reconnaissance Cultural Resource Survey for a Proposed Water Pollution Control Plant, Weymouth, MA; ICA 28; for Metcalf & Eddy, Inc.; September 1977.

Katuska, Charles; Conservation Administrator, Town of Weymouth; Personal Communication; January 1984.

Kevitt, Chester, D.; Weymouth, Massachusetts, A New England Town; Weymouth, Massachusetts, 1981.

Knight, Paul; Engineering Division, Weymouth Department of Public Works; Personal Communication; October 1983.

Kristnofe, William; Superintendent, Water Division, Weymouth Department of Public Works; Personalk Communication; May 1983.

Leopold, Luna B.; Water, A Primer; W.H. Freeman and Company; San Francisco, CA; 1974.

MacConnell, William P.; H.R. Pywell, P.E. Young; Remote Sensing 20 Years of Change in Suffolk and Norfolk Counties, Massachusetts, 1951 - 1971; Massachusetts Agricultural Experiment Station, College of Food and Natural Resources, University of Massachusetts at Amherst; Research Bulletin Number 624; November 1974.

Marino, Richard; Weymouth Board of Health; Personal Communication; November 23, 1983.

Massachusetts Department of Environmental Quality Engineering; Groundwater Quality and Protection, A Guide for Local Officials; Boston, Massachusetts; 1982.

Massachusetts Department of Environmental Quality Engineering; Water Supply Protection Atlas, 1983.

Massachusetts Special Legislative Commission on Water Supply; Water Quality Issues in Massachusetts - Chemical Contamination; Second Working Paper of the Special Legislative Commission on Water Supply; Revised October 1981.

McHarg, Ian, L.; Design with Nature; Published for the American Museum of Natural History; Doubleday Natural History Press; Doubleday and Company, Inc.; Garden City, NY '971.

Metcalf & Eddy, Inc.; Report to the Board of Public Works, Weymouth, MA upon Proposed Sanitary Sewer Additions - Part I Technical Report; Part II Environmental Assessment, Project I ; Part III Environmental Assessment , Project II; January 26, 1977.

Metcalf & Eddy, Inc., Report to Massachusetts Division of Water Pollution Control on Feasibility of Lake Restoration for Whitman's Pond, Weymouth, Massachusetts; May 1983.

Metropolitan Area Planning Council; Regional Decline or Revival An Interim Population Forecast for the Metropolitan Boston Region.

Metropolitan Area Planning Council; Groundwater Protection: A Guide for Communities; April 1982.

Metropolitan Area Planning Council; Underground Fuel Storage Manual; Fall 1982.

Nash, Gilbert; Historical Sketch of the Town of Weymouth, Massachusetts, from 1622 to 1884; Published by Town of Weymouth under the auspices of the Weymouth Historical Society; 1885.

National Academy of Sciences; Drinking Water and Health; National Academcy Press, Washington, D.C.; Volume I - 1977, Volume III - 1980.

New England Water Works Association; Introduction to Water Supply and Water Quality.

Nista, Anthony; Superintendent, Highway Division, Weymouth Department of Public Works; Personal Communications; September 2 and October 31, 1983.

Roy, Steve; Massachusetts Department of Environmental Quality Engineering; Personal Communication; November 7, 1983.

School Reuse Committee, Weymouth, Massachusetts; Part B - Developers Kit, Submittal Procedures and Zoning Bylaw; February 17, 1982.

Smith, Norman; Superintendent, Sewer Division, Weymouth Department of Public Works; Personal Communication; August 29, 1983.

Staff of Parks Division, Weymouth Department of Public Works; Personal Communication; December 1983.

Steele, Ernest W.; Water Supply and Sewerage; McGraw-Hill Series in Sanitary Engineering and Science, 4th Edition; Rolf Eliassen, Consulting Editor; 1960.

The Planning Services Group, Inc.; 1974 Open Space and Recreation Plan for Weymouth Conservation Commission; 1974.

Town of Weymouth, Massachusetts; Land Use Map, 1976.

Town of Weymouth, Massachusetts; Zoning Map, 1969.

Town of Weymouth, Engineering Division, Department of Public Works; Atlas of the Town of Weymouth; Revised to January 1, 1974.

Town of Weymouth, Massachusetts; Department of Public Works; Rules, Regulations and Policies - Various Services Performed and Conditions Governing Them; 1976.

Town of Weymouth, Massachusetts; Annual Report; 1982.

Town of Weymouth Board of Selectmen; List of gasoline storage licenses; compiled April 15, 1983.

Turpel, Donald; Fire Prevention Officer/Lieutenant, Weymouth Fire Department; Personal Communication; August 30, 1983.

U.S. Department of Agriculture, Soil Conservation Service and New England River Basins Commission; Southeastern New England Water and Related Land Resources Study; South Shore Coastal Streams; General Soils Map.

U.S. Department of Agriculture, Soil Conservation Service; Southeastern New England Study - Massachusetts, Rhode Island, Connecticut. Study Element 2.02 - Related Lands - General Soils Project - Preliminary Single Purpose Report; Draft, March 1973.

U.S. Environmental Protection Agency; Groundwater Protection - A Water Quality Management Report; Water Planning Division (WH-554); Washington, D.C.

U.S. Environmental Protection Agency; Water Planning Division; Land Use - Water Quality Relationships; Water Quality Management Guidance, WPD 3-76-02; Washington, D.C.; March 1976.

U.S. Environmental Protection Agency; Quality Criteria for Water; U.S. EPA, Washington, D.C.; July 1976.

Van Bossyt, Rufin; Arborist, Massachusetts Electric Company; Personal Communication; August 31, 1983.

Weston and Sampson, Inc.; Groundwater Resources - Braintree, Holbrook, Randolph, and Weymouth, for Massachusetts Water Resources Commission; July 1966.

Weston and Sampson, Inc.; Weymouth, Massachusetts Report on Water System Study; September 1971.

APPENDIX E - BYLAWS

ARTICLE A

WATERSHED PROTECTION DISTRICT

Section 1 - Intent

The Watershed Protection District is established for the following purposes:

a. to preserve and protect the lakes, ponds, streams, brooks, marshes, swamps, bogs, and other waterbodies and watercourses in the Town;

b. to protect, preserve and maintain the water table and water recharge areas within the Town, so as to preserve present and potential sources of water supply for the public health and safety;

c. to protect the community from the detrimental use and development of land and waters within the watershed protection district; and

d. to conserve the watershed areas of the Town of Weymouth for the health, safety, welfare, and enjoyment of its people.

Section 2 - Establishment; determination of boundaries

The Watershed Protection District includes those areas that fall within the catchment or drainage areas of the Town's public water supply. The district includes all areas delineated on the Watershed Protection District Maps, approved on file with the Town Clerk, Building Inspector, Planning Board, and Engineering Division of the Weymouth Department of Public Works.

Where interpretation is needed as to the exact location of the boundaries of the district, the Building Inspector shall make the necessary interpretation.

The Watershed Protection District is an overlay district and shall be superimposed on the other districts established by this bylaw. No use not permitted in the portions of the districts so overlaid shall be permitted within the district.

Section 3 - Permitted Uses

The overlay district shall impose the following criteria and/or requirements for each underlying zoning district.

A. Resident District R-1

1. Minimum lot size shall be 25,000 square feet.

2. A parcel of land, with approval of the Planning Board, may be subdivided into 20,000 square foot lots provided that:

   a. the net density does not exceed that which would be allowed for 25,000 square foot lots; and

   b. the remaining environmentally sensitive land is suitably restricted from development by deed restriction, easements or dedication to the Town for conservation purposes, whichever form meets the approval of the Planning Board.

3. Maximum lot coverage shall be 25%.

B. Business District B-1 and B-2

For all permitted uses, a site plan must be reviewed by the Planning Board.

C. Industrial District I-1

For all permitted uses, a site plan must be reviewed by the Planning Board.

Section 4 - Prohibited Uses

The following uses are prohibited in the overlay zone:

a. solid waste disposal landfills;

b. surface waste impoundments designed to leach their wastes to the ground;

c. open road salt storage and dumping of salt-contaminated snow;

d. discharge to the ground or surface water of sanitary waste water provided that municipal sewage connections are available;

e. discharge to the ground or surface water of industrial waste water; and

f. construction within 25 feet of the high water line of all surface water bodies.

TOWN OF WEYMOUTH

UNDERGROUND FUEL STORAGE BYLAW

Section 1: Authority

This bylaw is adopted by the Town of Weymouth under its home rule powers, its police powers to protect the public health and welfare, and its authorization under Massachusetts General Laws Chapter 40, Section 21.

Section 2: Purpose

The purpose of this bylaw is to control the installation and maintenance of underground gasoline or fuel storage tanks over 1,000 gallons, and to protect groundwater and surface water from contamination due to leakage. The provisions of this bylaw are applicable only to underground tanks.

Section 3: Definitions

3.1 - Underground tank shall mean any fuel-storage containment system for gasoline, fuel or lubricating oil with a capacity in excess of 1,000 gallons, the top of which is located below the ground.

3.2 - Fire chief shall mean the chief of the Town of Weymouth fire department.

3.3 - Noncorrosive soil is soil that, when tested by a qualified professional, is shown to have a resistivity greater than 10,000 ohm-cm, and that does not exhibit corrosive characteristics in a soil-chemistry analysis.

3.4 - 100-year floodplain shall mean those areas as shown in the Flood Insurance Rate Maps for Weymouth under the Federal Emergency Management Agency's National Flood Insurance Program, or as defined in Section 120-38.1 of the zoning bylaw.

Section 4: Registration of Existing Tanks

Note: Section 4 to be based on existing procedure for licensing and inspections.

Section 5: Standards Applicable to the Installation of New Tanks

5.1 - Tank Design

(a) Unless proven otherwise by soil tests performed by qualified professionals, the soils in Massachusetts shall be assumed to be corrosive. Metallic tanks (except stainless steel) without cathodic protection or an underground secondary-containment system will be prohibited. Also

prohibited is schedule 40 steel pipe, galvanized or black iron, or approved nonmetallic (except fiberglass-reinforced plastic) pipe. If a qualified professional demonstrates that the soils in which the tank is to be placed are non-corrosive as described in Section 3.3 of the definitions, a steel tank with interior coating and other approved piping may be installed.

(b) In corrosive soils, underground tanks must be constructed of: non-corrodible materials, such as fiberglass-reinforced plastic (FRP) or its equivalent; steel with external bonded non-corrodible material (i.e., FRP); a steel system cathodically protected by an impressed current cathodic system, sacrificial anodes, or equivalent protection; or, a double-walled tank. These requirements are in accordance with the Massachusetts Board of Fire Prevention regulations codified in 527 CMR 9.06 (18).

(c) In corrosive soils, piping shall be constructed of non-corrodable materials such as FRP or its equivalent, a steel system with cathodic protection, or some other type of equivalent protection, in accordance with 527 CMR 9.06 (18).

(d) Cathodic protection systems shall be maintained and checked in accordance with 527 CMR 9.06 (20)(g).

(e) Commercial tanks must be equipped with striker plates below openings used for product measurement or filling.

5.2 - Tank Installation

(a) The fire chief or his designee must inspect and approve underground tanks prior to their burial, in accordance with 527 CMR 9.06 (10).

(b) Tanks must be installed in accordance with the manufacturer's installation techniques. Damage to protective coatings or to the FRP tank or surface must be repaired prior to covering the tank.

(c) New underground tanks shall be tested for tightness, hydrostatically, or with air pressure at not less than 3 pounds per square inch and not more than 5 pounds per square inch after installation, but before being covered or placed in use in accordance with 527 CMR 9.06 (20(b).

(d) Piping should be tested in accordance with 527 CMR 9.06 (20)(a) before being covered, enclosed, or placed in use.

(e) Backfill material, used to cover all new tank installations and repairs, must be of the type and quality specified by the tank manufacturer's installation procedures, and by the pertinent regulations governing storage tank installation.

(f) Underground tanks that are to be located in areas subject to flooding or below the maximum water table elevation must be anchored according to manufacturer's instructions and to the satisfaction of the fire chief or his designee.

5.3 - Tank Location

(a) Underground tanks may not be installed within the 100 year floodplain. Underground tank installation is also prohibited within 100' of Whitman's Pond, Mill River and Swamp River; and within 400' of Great Pond and all Town water supply wells.

(b) Underground tanks that are to be installed within the watershedof a drinking-water reservoir, or within the cone of depression of a public well (or lacking a defined cone of depression, within 1,000 feet of public water supply well), must submit, for review by the fire chief, the Board of Health or its agent, and the local water commissioners or their agent, a plan outlining the procedures or devices, such as product sensors and/or area monitoring devices, to be used to prevent water supply contamination. The plan must be endorsed by representatives of the three departments noted above prior to tank installation.

Section 6: Leak Detection for Existing and New Tanks

6.1 - Inventory Verification

(a) All underground tanks, except fuel-oil tanks and tanks connected with burning equipment, must be monitored for the prevention and detection of leakage of flammable and combustible liquids in accordance with the provisions of 527 CMR 5.05 (3).

(b) The daily-inventory records must be shown to the fire chief, or his designee, prior to issuance of a permit or license renewal.

(c) The owner and operator must participate in a program of regularly scheduled inventory verification, at least once every two years, in accordance with 527 CMR 5.05 (3)(g). The operator of tanks 10 years of age or older shall submit to the fire chief annually a report certifying that the inventory verification has been performed, stating the calculated gain/loss over the verification periods.

(d) The fire chief shall require the operator of an underground tank storage system to test the system for tightness, at the operator's expense, when accurate daily inventory records have not been maintained as specified in 6.1.

(e) If daily inventory records indicate a loss of product in excess of 0.5 percent of the volume of product used or sold, or an abnormal increase in the amount of water contained in the tank, steps must be taken immediately in accordance with 527 CMR 5.05 (3)(e) to detect and stop the leak. The discrepancy must be reported to the fire chief.

6.2 - Tank Testing

(a) Unless the tank operator demonstrates to the fire chief and the Board of Health that his tank(s) are constructed of a material that will not corrode, has product sensors, or has been repaired or tested within the last year, underground tanks shall be required, at the expense of the owner, to undergo one of the following tests at five-year intervals from the date of installation, up to the twentieth year, and annually thereafter: A Kent-Moore (Health Petro-tite) test; or a Sun-Mark leak-locator test; or the equivalent as determined by the fire chief. The fire chief shall be given at least 48 hours' notice of time, date, and place of testing. Test results must be submitted to the local fire chief.

(b) The waiver from 6.2(a) may not be granted for a tank that is located within any of the areas specified in Section 5.3(b).

(c) If flammable fluids or their vapors have been detected in neighboring structures, sewers, or wells on or off the property locations, the fire chief may require that any nearby tank, including underground residential tanks less than 1,000 gallons, be tested at the expense of each tank's owner.

Section 7: Procedure in Case of Spill or Leak

7.1 - Leak Reporting

Any person who is aware of a spill or abnormal loss of flammable fluids must report such spill or loss immediately to the fire chief. The fire chief must be responsible for other notification, including the Board of Health.

7.2 - Equipment Replacement/Removal

(a) After a leak is confirmed, underground tanks (or piping) must be emptied immediately, and removed or repaired forthwith, under the direction of the fire chief.

(b) A leaking tank that is twenty years old or older that does not comply with the design standards in Section 5.1(b) must be removed and may not be repaired. a permit for its remmoval must be obtained in accordance with M.G.L. Ch. 48, Sec. 38A.

(c) A leaking tank that is less than twenty years old must be repaired or removed. If the tank operator can show to the satisfaction of the fire chief that (in the case of steel tanks) the leak was from internal corrosion, and that the tank can be repaired so as not to pose a continuing threat to the soils and waters of the Commonwealth, considering at a minimum the corrosivity of the soil; tank age and external condition; techniques to be used for the repair; and the location of the tank, then the tank may be repaired. Operators of leaking FRP tanks must demonstrate to the fire chief that the tank can be repaired according to manufacturer's instructions. Operators who do not meet these requirements must remove the tank.

(d) If it is necessary to replace an underground steel tank that has developed a corrosion-induced leak, all other steel tanks at the facility of the same age or older, whether they are leaking or not, shall be repaired or replaced with tanks that meet the requirements of Section 5.1 of this bylaw.

Section 8: Administration

8.1 - The provisions of this bylaw shall be administered by the fire chief.

8.2 - Variances from the specific requirements of this bylaw may be authorized by the chief licensing authority after notice and a public hearing.

8.3 - Licenses issued in accordance with M.G.L. Ch. 148 Sec. 13 for underground tanks must be renewed at five year intervals from the date of installation, up to the twentieth year, and annually thereafter. Tank owners must submit to the fire chief and the licensing authority a statement certifying satisfactory leak-detection results over the period of the license (in accordance with Sec. 6.2 of this bylaw), and inventory verification, at least 30 days before the issuance of a permit renewal for the time periods specified herein. Test results must accompany the license renewal application.

8.4 - Fees necessary for the issuance and renewal of permits or licenses shall be set by the Board of Selectmen.

8.5 - The fire chief or his designee may, at all reasonable times, and upon reasonable notice to the occupant of the premises, enter any premises, public or private, for the purpose of investigating, sampling, or inspecting any record, condition, equipment, practice, or property relating to activities subject to this bylaw, and may at any time and upon reasonable notice to the occupant of the premises enter such premises for the purpose of protecting the public health or safety, or to prevent damage to the environment.